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Goat Meat Production in Asia

Proceedings of a workshop held in Tando Jam, Pakistan, 13–18 March 1988

Proceedings

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Goat Meat Production in Asia

Proceedings of a workshop held in Tando Jam, Pakistan, 13–18 March 1988

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Abstract/Résumé/Resumen

Abstract: This publication presents the results of a workshop held in Tando Jam, Pakistan, 13–18 March 1988, that focused specifically on all aspects of goat meat production in Asia. The workshop addressed the factors affecting meat production (breeding, nutrition, reproduction, sex, management, animal health, and diseases), the nutritional value of goat meat, methods of slaughter, processing techniques, consumer preferences, and the national and international marketing of goats. The detailed discussions on these aspects were further highlighted by country case studies, prevailing situations, issues and policies, and potential for improving the prevailing patterns of production. An important session covered broader issues concerned with research and development, strategies for increasing production, and export potential, especially in Near East markets. These discussions enabled a definition of research and development priorities and the scope for increasing goat meat production.

Résumé: Cette publication fait le compte rendu d'un atelier tenu à Tando Jam, au Pakistan, du 13 au 18 mars 1988 et qui a porté sur tous les aspects de la production de la viande de chèvre en Asie. Il y a été question notamment des facteurs influant sur la production de la viande (sélection des espèces, nutrition, reproduction, sexe, gestion, santé animale et maladies), de la valeur nutritive de la viande de chèvre, des méthodes d'abattage, des techniques de transformation, des préférences des consommateurs et du marketing national et international des chèvres. En plus de discuter de ces questions en profondeur, les participants ont aussi abordé les points suivants : études de cas de certains pays, situations actuelles, enjeux et politiques, et possibilités d'améliorer les tendances actuelles de la production. Lors d'une séance importante, les participants se sont penchés sur des questions plus vastes concernant la recherche et le développement, les stratégies qui permettraient d'augmenter la production et les possibilités d'exportation, particulièrement vers les marchés du Proche-Orient. Ces discussions ont permis de définir des priorités en matière de recherche et de développement et de déterminer le potentiel de croissance de la production de la viande de chèvre.

Resumen: Esta publicación contiene los resultados de un taller celebrado en Tando Jam, Paquistán, del 13 al 18 de marzo de 1988, dedicado específicamente a todos los aspectos de la producción de carne de cabra en Asia. El taller estudió los factores que afectan la producción de carne de cabra (cruce, nutrición, reproducción, sexo, manejo, salud y enfermedades), el valor nutricional de la carne caprina, los métodos de sacrificio, las técnicas de procesamiento, las preferencias del consumidor y el mercado caprino nacional e internacional. Las discusiones detalladas sobre estos aspectos se vieron además enriquecidas con el potencial para mejorar los patrones prevalecientes de producción. Una de las sesiones importantes cubrió los aspectos más amplios de investigación y desarrollo, estrategias para el aumento de la producción, potencial de exportación, especialmente en los mercados del cercano oriente. Las discusiones permitieron determinar las prioridades de investigación y desarrollo así como las posibilidades para aumentar la producción de carne caprina.

Contents

Prime Minister's Message

I am happy to learn that an international workshop on goat meat production is being organized by Sind Agriculture University, Tando Jam, in collaboration with the International Development Research Centre, Canada. The workshop will provide an opportunity to experts of the participating countries to exchange views on research done so far in this field and to devise ways and means of increasing the production of meat. Despite possibilities offered by genetic engineering and the availability of modern technology, most animals still produce meat below their potential. The experts would like to debate this and other similar issues.

It is a matter of satisfaction that the animal industry is rapidly acquiring a prominent position in the agricultural economy of developing countries. Mankind has succeeded in exploiting animal production potentials for maximum gain in terms of human food, but there is still a lot to be done.

Pakistan possesses some of the finest goat breeds, which are well adapted to its environmental conditions. As a result of incentives provided by the Government, there has been a resurgence of interest in investment in agrolivestock ventures and large livestock farms. The Government also provides facilities to foreign investors to encourage farm investment in bilateral agrolivestock complexes and ventures. The private sector has started to show keen interest in the establishment of feed lot units. This should go a long way in promoting the livestock sector.

I am confident that the workshop will bring into sharper focus the problems presently hampering the growth of the meat industry in Asia in general and in Pakistan in particular. The efforts of Sind Agriculture University for organizing this workshop are really commendable.

I wish the workshop all success and hope that its recommendations will greatly benefit the policymakers and planners.

PRIME MINISTER

Foreword

Meat production from large and small ruminants represents the principal function of swamp buffaloes, beef cattle, goats, and sheep throughout Asia. For the vast majority of small farmers who own these animals, meat production is an important source of income and a means of alleviating rural poverty. Among ruminant species, goat and sheep populations have shown the fastest growth rates. This is consistent with their wider presence in small farm systems, their important biological attributes, and the wide demand for their meat and by-products.

Projections by the International Food Policy Institute based on historical trends suggest that, in Asia, the gap between supply and demand for all meats will increase until the turn of the century. This trend is despite a projected increase in meat production, approximately 60% of which will be accounted for by ruminant meat. The projections suggest that the demand for meat in response to trends in real income and economic growth will outstrip the capacity of the region to meet consumer requirements. More particularly, the projections emphasize the need for increased efficiency in the use of existing resources, higher investment in research and development efforts, and the formulation of innovative strategies that can increase the current level of meat production.

Goat meat is relished throughout Asia and goats are distributed widely in all agroecological zones. Among the ruminant meats, goat meat probably has the highest income elasticity of demand, reflected by having the highest price per unit meat in the market. The demand for goat meat is associated with factors such as the preference for a relatively high lean meat content and the absence of religious taboos. Recently, a significant demand for goat meat has been generated by the substantial export potential to the lucrative markets of the Near East. This has resulted in a shift to more intensive systems of production.

Recognizing these features, the International Development Research Centre was pleased to sponsor and organize a workshop that focused on all aspects of goat meat production. Several resource papers were presented addressing factors concerned with production, as well as slaughter methods, processing, marketing, consumer preferences, economics of production, and potential for export to the Near East region. In addition, country studies highlighted current and contrasting situations. The final session of the workshop was devoted to discussing the major issues concerning the future research and development of goat meat. These proceedings embody the results of these efforts to strengthen and sustain goat meat production in Asia.

H.G. Zandstra
Director
Agriculture, Food and Nutrition Sciences Division
International Development Research Centre

Acknowledgments

The International Development Research Centre (IDRC) wishes to thank Drs Amir Muhammed, Abdus Salam Akhtar, and Muhammad Anwar of the Pakistan Agricultural Research Council (PARC), Drs A.Q. Ansari, G.B. Isani, and G.H. Soomro of Sind Agriculture University, Tando Jam, and Dr G.M. Memon, Director, Department of Livestock, for their valuable support. Special thanks are extended to the several scientists and institutions who participated in the workshop and contributed to the realization of this publication. Support of the following organizations in funding the participation of their staff is gratefully acknowledged: the Food and Agricultural Organization of the United Nations, the Ministry of Foreign Affairs, New Zealand, and Winrock International. Summaries of individual sessions and group discussions were presented by the following participants: Drs R.M. Acharya, P. Amir, A.S. Alvi, N.K. Bhattacharyya, A.H. Kirton, A.S.B. Rajaguru, B.K. Soni, G.H. Soomro, A.W. Qureshi, and M.K. Vidyadaran.

Introduction

C. Devendra

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Goat meat accounts for approximately 63% of the total volume of the meat produced in the world, and the per caput (per adult) supply of goat meat is on the decline in Asia. This clearly suggests that the contribution by goats has failed to keep pace with the increasing demand for meat by humans and projected national targets. In turn, this has produced reservations about the efficiency of prevailing goat production systems and the techniques that are now being used to produce the meat.

This workshop was therefore directed to examine and inquire into prevailing patterns of production and to provide a comprehensive assessment of the current situation. This was mainly achieved by key resource papers that examined in detail a variety of factors affecting production in the context of different production systems. The workshop was attended by 54 participants from 14 countries.

The workshop was structured into four main sessions. The first analyzed the effects of different disciplines (breeding, nutrition, reproduction, and animal health) on production. The second session discussed the effects of management, handling, and slaughter and processing techniques. The papers in both sessions focused on quantitative and qualitative aspects of meat production, including a reference to total edible and total saleable proportions. The third session was devoted to economics of production, marketing patterns, utilization of by-products from meat production, international trade, and export potential in the Near East region. These resource papers were complemented by a session consisting of case studies from 10 countries in the Asian region. These country case studies were particularly valuable in describing the varying patterns of goat meat production, levels of production, major constraints to production, extent of research support, and opportunities for improvement. The final session was devoted to working group discussions on the quantitative aspects, qualitative aspects, and economics and marketing of goat meat. Research priority areas were identified and these discussions produced the main recommendations of the workshop.

In addition to workshop sessions, participants attended a goat show in Hala. Farmers exhibited about 700 animals involving 10 distinct breeds and were awarded trophies. The availability of these outstanding breeds, their apparent attributes, and what can be done for meat production left an everlasting impression on everyone who attended the show.

The workshop was extremely useful in summarizing, for the first time, the situation concerning goat meat as a major commodity in Asia. It also provided a valuable forum to promote communication at a variety of levels between individuals and countries. More than anything, the workshop was especially timely in addressing potential improvements and strategies for increasing meat production from goats by strengthening national research and development programs.

Welcoming address

Dr A.Q. Ansari

Vice Chancellor,
Sind Agriculture University, Tando Jam

It is my privilege to welcome you all to the Workshop on Goat Meat Production in Asia on behalf of Sind Agriculture University, Tando Jam, Pakistan, the Pakistan Agricultural Research Council, Islamabad, Pakistan, and the International Development Research Centre, Canada. It is our pleasure to have amongst us a galaxy of eminent scientists who have come to attend the workshop from Pakistan and many foreign countries. I am profoundly grateful to the Honourable Mr Justice (Retired) Syed Ghous Ali Shah, Chief Minister of Sind, for accepting our invitation and for having come to Tando Jam to inaugurate the workshop despite is heavy schedule of engagements.

Sind Agriculture University, in collaboration with the Pakistan Agricultural Research Council and the International Development Research Centre, is pleased to host this workshop of international importance. I am sure this meeting will significantly enhance the dissemination of knowledge on goat meat production through paper presentations, discussions, and invited speeches. Hopefully, the workshop will provide an excellent forum to the scientists from various organizations, institutions, and universities, in Pakistan and abroad, to coordinate their research in progress with that of their fellow scientists and to enrich and extend their research by sharing experiences and making use of new ideas, techniques, and methodologies learned during these deliberations.

The livestock subsector has stabilized to a considerable extent in our country. It contributes about 8% to the gross domestic product and accounts for 30% of the value added in our agriculture sector. In the livestock subsector, goat occupies an important position. In the struggle for existence, goat has proved its worth over the global ecosystem and has emerged as a source of livelihood for millions of landless farmers and socioeconomically backward rural population in this part of the world. On the world scene, goat accounts for 15.3% of total domestic livestock. Of this, over 50% is in Asia. In Asia, the largest goat populations are in India, the People's Republic of China, and Pakistan. Pakistan is the third-largest producer of goats in Asia.

According to the *Economic Survey of Pakistan 1986–87*, the estimated total goat population of the country is 31.9 million, of which approximately 16 million (nearly 50%) is slaughtered annually. This massive goat slaughter, as estimated by the Food and Agriculture Organization of the United Nations (FAO) in 1985, contributes 250,000 t/year of meat, which is about 27% of the total red meat production in the country. Goats also contribute 4% of total milk production of Pakistan. Apart from this, 35,000 t/year of goat skins are produced in Pakistan in addition to

the other valuable products like hair, casings, offal, bone, blood, body fat, glands, and manure.

When we look at the tremendous contribution made by goats to the national economy and, simultaneously, examine the extent of investment in goat production, we find that the investment is negligible. Goats are, therefore, rightly classified as "low-input agriculture." Goats mostly subsist on the scarce vegetation available in the deserts, browse on steep slopes and hills, or feed on brush, twigs, tree tops, and thorny herbage, converting them into precious edible products for human use. The goat is never a competitor with man and survives in arid zones and other unfavourable environments where normal agricultural operations cannot be carried out and where cows or buffaloes would die of starvation. With this vast potential, the goat has become the principal meat animal in the region and plays a dominant role in small-farm animal-production systems. Thus, it is the economic significance of the goat that has prompted us to spotlight this animal by organizing an international workshop.

It is in this context that, in this workshop as well as in the future, we pin our hopes on the scholars and scientists to dedicate themselves to research exploring effective and realistic methods by which this precious species can multiply quickly enough to meet the nutritional needs of Asia.

Sind Agriculture University, Tando Jam, looking at the present trends in livestock production research, has recently documented about a dozen goat breeds exclusively belonging to Sind Province. We have increased the farm inventory by adding nearly 200 goats of different breeds to conduct comparative studies on their productive and reproductive characteristics, their economics, and their meat and milk production to rationalize their utilization. To maximize the production capabilities of various goat breeds, it is imperative to identify the critical gaps in production systems, to use genetic improvements, control climatic and nutritional stress, prevent infectious and parasitic diseases, and to improve goat husbandry and management systems.

Although health campaigns are carried out by effective vaccination programs, the goat population experiences heavy losses as a result of infectious diseases like anthrax, enterotoxemia, contagious caprine pleuropneumonia, and scabies. Undoubtedly, the challenge lies on our shoulders to conserve and manage this precious natural resource and increase its production potential to keep pace with the ever-increasing demand for animal protein.

Coming back to the workshop, 51 participants from 14 countries are attending the workshop and 23 research papers in various fields of goat meat production are expected to be presented. The participants, apart from their paper presentations and discussions, will visit Hala, where a goat show has been organized in their honour by the Department of Animal Husbandry, Extension Services, Sind, and this university. This is yet another outreach program of this university (like the one on tile-drainage systems recently organized at Sujawal) that will directly benefit the farmers.

I extend my sincere gratitude to Dr C. Devendra of the International Development Research Centre, Canada, who supported the idea of holding this international workshop at Tando Jam. I am also grateful to Dr B.K. Soni of the FAO Animal Production and Health Commission for Asia and the Pacific (APHCA), who, while on his visit to our Faculty of Animal Husbandry and Veterinary Sciences and after seeing our goat research program, proposed Sind Agriculture University as the venue for this workshop. I am also grateful to the Pakistan

Agricultural Research Council, Islamabad, for cosponsoring this workshop. Our appreciations are also due to the Department of Animal Husbandry, Sind, for their cooperation in organizing the goat show at Hala.

We at Sind Agriculture University Tando Jam, are honoured to be hosting this workshop and wish all of you well in your deliberations and hope that your stay will be enjoyable. We are looking forward to the coming 5 days of useful and purposeful presentations, discussions, and deliberations. I am confident that your deep insight and profound professional wisdom will make the workshop inspiring and fruitful for the scientific community of Pakistan.

I take this opportunity to sincerely acknowledge the support of the honourable chief guest, Mr Justice (Retired) Syed Ghous Ali Shah, Chief Minister of Sind, who has always taken a deep interest in the development of the academic, research, and extension programs of Sind Agriculture University. Motivated by his inspiring guidance while inaugurating the Extension Education Building of the University in 1982, we have worked hard to initiate a problem-solving research and technology-transfer program. We also plan to build our research programs in crop and animal sciences.

In conclusion, I am thankful to the Chief Minister for inaugurating this international workshop and also wish to thank all the dignitaries, guests, and participants for sparing their time to attend this historic occasion. I am equally thankful to the teachers, administrative staff, and workers of Sind Agriculture University, who have dedicated their energies in organizing the workshop. I commend Dr Ghous Bakhsh Isani and his colleagues in the Faculty of Animal Husbandry and Veterinary Sciences for their excellent organizational skills.

Keynote address

Abdus Salam Akhtar

Member (Animal Sciences),
Pakistan Agricultural Research Council, Islamabad, Pakistan

It is my privilege to welcome you all to this international workshop on behalf of a minor but significant cosponsor, the Pakistan Agricultural Research Council. It is an honour to be asked to present the keynote address for this workshop. I have had occasion to listen to several keynote addresses on different topics and many of the addresses were laced with lot of statistics and were generally found to be boring. To avoid this criticism, I have tried to keep this address simple but realistic.

Population

In Pakistan's context, goat has not been a neglected species. In fact, it attracted such great attention in the early 1960s, during the regime of President Ayub Khan, that a decision was taken at the highest level that this animal be exterminated; special laws to this effect were enacted. For every sheep slaughtered, three goats were to be slaughtered. But, proving the resilience of goat, despite all the prejudice and all the bureaucratic snares, goat not only survived but also thrived and, today, Pakistan has a population of about 31 million goats. This accounts for around 12% of the goat population of Asia, ranking third behind India (37%) and the People's Republic of China (23%). Iran has perhaps the largest population in the Near East region. According to the 1987 *Statistical Profile of Livestock in the Asia–Pacific Region* of the Food and Agriculture Organization of the United Nations (FAO), the world population of goats in 1986 stood at 492 million, of which Asia and the Pacific had 248 million, a little over 50% There is a wide range in goat distribution in Asia from the arid regions of India and Pakistan to the humid tropics of Indonesia and Malaysia.

Economic importance and functions performed

Goat is a multifunctional animal and one of nature's best scavengers of different types of vegetation and waste. Its feeding spectrum ranges from tender twigs and leaves of plants (infuriating foresters) to thorny bushes, citrus and banana peelings, and paper. Excellent products are derived from such poor-quality browsing or roughage: i.e., meat, milk, hair, skins, horns, hooves, blood (for producing meal), and manure (as a source of fertilizer).

For transhumant flocks, goats are convertible liquid cash and a means of investment. Along with other livestock species, they provide security against crop

failure. Dancing goats (like the Nachi breed) provide recreation at village festivals. Goats have also been used for transportation purposes in countries like Bhutan, Sikkim, and Nepal. What more could this animal provide? Very few animals are such gifted converters of roughage and endowed with the capability to perform such important functions.

Breeds and breeding

In general, goat flock sizes are small. The bulk of goat owners (75%) keep 5–7 goats, 20% own less than 50 goats, and a small percentage (2%) own more than 50 head. Therefore, goat raising is a noncommercial, smallholder activity, including tens of thousands of landless owners. Until recently, and only in few countries of Asia, there has been little controlled breeding of goats. Although some breeds are not properly documented, it is estimated that the Asian–Pacific region has 25 breeds of goat, the majority of which are found in India, Pakistan, and Bangladesh.

Many of these breeds are dual purpose, i.e., good for milk as well as for meat production. Some of the more renowned breeds are Barbari, Beetal, Damani, Daira Deen Panah, Jamunapari, and Kamori. There are others that are good meat producers such as Nubian, Fijian, Kambing Katjang, Matou, and Sirohi. Breeds such as Black Bengal, Malabari, Barbari, and Matou are especially known for the prolificacy. In Pakistan, aside from the Teddy goat, there is no distinct breed that is raised only for meat production. Beetal and Kamori are excellent breeds, both for milk and meat production. I do not know if this workshop will recommend the development and propagation of goat breeds exclusively for meat production, but because "goat is a poor man's cow," it may be of advantage to breed dual-purpose goats, particularly where goat milk has such an important impact on the nutrition of rural families living close to the poverty line.

Most breeds have not been studied systematically. Therefore, their production potential has not yet been fully exploited.

Constraints to production

It is well known that the present levels of goat production throughout Asia are low. Some of the factors that are responsible for such low productivity are the following:

- inadequate nutrition,
- death and depreciation because of diseases and parasites,
- unorganized marketing of live animals and products,
- inadequate research on breeding of improved stock,
- undefined production objectives,
- inadequate financial resources for goat research and development programs,
- lack of proper infrastructure and properly integrated farming system, and
- inadequately trained labour.

Unless special attention is paid to removing these constraints, goat production will not progress on proper scientific lines. This international workshop should pay special attention to identifying the factors that will stimulate interest

on research and development of goats in Asia. A development strategy must be enunciated during workshop deliberations.

Scenario by the year 2000

Although there has been a resurgence of interest in goats as farm livestock during the past decade, the development effort has not been commensurate with the economic importance of this animal, particularly to the rural, resource-poor population. Judging from the rising demand for goat meat, especially among the more affluent consumers, the goat population will increase considerably by the year 2000. According to FAO estimates in 1977, the goat population in Asia in 2000 will be 342 million: an increase of 47.4%. In 1986, the goat population was 248 million. It appears that during the next 12 years, the goat population will increase rapidly.

Will these increased numbers be able to meet the demand for goat meat by the increased human population in the year 2000? Will the existing and future resources of feeds and feeding be adequate to support the projected goat population? The experts feel that this support is questionable. A strategy may, therefore, need to be developed where an intensive production system that is fully integrated into the cropping system is introduced. Some of the selected breeds that have shown promise should be used for upgrading flocks to improve their productivity. This may necessitate monitoring and evaluating comparative advantages and, perhaps, a reduction in the overall inventory, replacing poor-producing herds with high-producing stock.

In conclusion, I would like to commend the initiative of the International Development Research Centre in general and Dr C. Devendra in particular for organizing this workshop, the first of its kind in Pakistan, that will pave the way for the improved development of goats in Asian countries with particular attention to meat production. I would also like to take this opportunity to mention the wisdom and vision of Dr A.Q. Ansari, the illustrious Vice-Chancellor of Sind Agriculture University, in hosting this workshop. The benefits that will accrue from the deliberations during the next week will not be confined to this campus alone, but will hopefully have a much wider scope. To you, Mr Chief Minister, we owe a special debt of gratitude for sparing your valuable time for this inauguration.

I look forward to a week-long intellectual feast on this beautiful campus and hope that the participants will enjoy the traditional warmth and hospitality of our friends and colleagues in Sind Province. I thank the organizers for their wonderful arrangements and sincerely wish this workshop much success.

Opening address

Syed Ghous Ali Shah

Chief Minister,
Government of Sind, Karachi, Pakistan

It gives me great pleasure to inaugurate this international Workshop on Goat Meat Production in Asia, arranged by the Sind Agriculture University, Tando Jam, the Pakistan Agricultural Research Council, and the International Development Research Centre, Canada. I am grateful to the organizers for providing me a forum to address this august house.

I understand that the present workshop has been convened to deliberate upon the recent advances and newer dimensions that have emerged in the field of goat production. I am glad to learn that a large number of delegates are participating in the workshop. No one can overlook the key position of goats in the livestock production systems of Asia. Indeed, this otherwise neglected species has for ages played a vital role in the lives of rural farmers and landless peasantry.

Two decades ago, goats suffered a setback through the promulgation of a goat-restriction ordinance in Pakistan, on the plea that the goat was a destroyer of forests. Farmers consistently opposed this gruesome regulation, however, and, ultimately, the ordinance was withdrawn. Today, goat is being projected as the protector of forests!

Agriculture in most developing countries has retained its traditional systems. In Pakistan, agriculture is the largest single sector of the economy, accounting for 37% of the gross domestic product (GDP). Agriculture has maintained a steady pace of expansion and has placed Pakistan in the select group of developing countries that have succeeded in inducing and sustaining high agricultural growth. The livestock sector in Pakistan accounts for about 28% of the GDP in agriculture and contributes 15.7% to the total export earnings. In Pakistan, the livestock resources have considerable potential for production increases in terms of milk, beef, mutton, and goat meat. The livestock industry as a whole employs over 50% of the population of this country. It is a major source of animal protein and cash flow to the rural farmers.

Rural development lies at the heart of any meaningful development strategy. The rural population accounts for over 70% of the total population of this country. In Pakistan, the average rural income is 34% less than the per capita urban income. The rural-development effort of the Sixth Five-Year Plan (1983–88) has almost achieved the targets fixed for agricultural productivity by improved input availability and decisive breakthroughs in the rural infrastructure.

Sind Province of Pakistan is divided into different agroclimatic zones, symbolizing highly specific conditions for livestock production and being rich in livestock breed potential. Sind Province is conspicuously different in its livestock

resources from other parts of Pakistan. For the majority of farmers in this province, livestock raising is subsidiary to crop production, except in the dryland areas of Thar and Kohistan, where the mainstay of the economy is livestock production. Sind Province has been blessed with Kundhi buffalo, Red Sindhi and Tharparkar cattle, and Kamori goat, all have gained a reputation for being among the best dairy breeds in the tropics and subtropics. Sind Province is a fine example of an area with mixed crop and livestock systems.

Agriculture, including livestock, is a huge, diverse, and conservative industry and it is not easily changed. Overall, farming in developing countries will probably still look much the same during the coming decades. It may change in some areas through the use of biotechnology, but it will depend on the scientific community of Asia how fast these technologies will be introduced. Indeed, the livestock industry requires, on your part, deep insight, intellectual endeavour, thought, and concert to accelerate the pace of development considering the inexorable rise in the world and Asian populations. Asian scientists must undertake to achieve better standards in the quality and quantity of livestock production to meet the ever-increasing demand for food of animal origin and, simultaneously, work to improve the income and living standard of rural farmers.

New technologies developed in Europe have changed land-use systems, increasing crop yields and improving the productivity of individual animals. It has been claimed that by the year 2015 a total of 40×10^6 ha in Europe will no longer be used for the primary purpose of food production. The situation is the reverse in Asia, where we are adding land to the total cropped area and increasing the animal population because of the low yield per hectare and per animal. We all, therefore, should intensify our efforts and strive together to bring immediate changes in farm production technology, leading to an increased output from available resources and to revolutionize the livestock sector of Asian agriculture.

In conclusion, I wish you much success in your deliberations and thank you for allowing me to share some of my thoughts with you on this occasion. I have great pleasure inaugurating the workshop, which I do with fervent hope and joy on this day, 13 March 1988.

Session I

Quantitative Factors

Goat breeding and meat production

R.M. Acharya

Indian Council of Agricultural Research,
New Delhi, India

Abstract: *Based on the performance of Indian goats, performance-related characters affecting meat production such as growth, reproductive performance, survival, adaptation, feed efficiency, and carcass characteristics are discussed. Based on the intra- and inter-breed differences and estimates of genetic and phenotypic parameters of characters related to meat production, selection for improving meat production can be based on 6-month body weight. Of the Indian breeds, Beetal is preferred because of its high reproductive rate and adaptation compared with Jamunapari. Crossbreeding with exotic dairy breeds improves body weight with a decline in reproductive performance, especially in multiple births. Of the exotic dual-purpose breeds, Anglo-Nubian appears to perform well. There is a need for greater attention to the indigenous goat breeds, their conservation, and their management. Less emphasis should be given to increasing numbers in countries such as India because populations are already large; however, reproductive rate and survival can increase meat production without increasing the number of breedable females. There are large inter- and intra-breed differences in these traits. A number of schemes for improving goats for meat production are proposed; however, it is desirable to involve farmers' flocks in breed-improvement programs. Surveys of farmers' flocks to select animals with better than average performance and that conform to breed type will be useful in producing superior bucks for further use in such flocks. It is also feasible to organize cooperative group-breeding schemes with nucleus flocks of selected males and females and utilizing these schemes to produce superior breeding males for meat production.*

Résumé: *Discussion, à partir du rendement des chèvres indiennes, des traits qui influent sur la production de viande : croissance, reproduction, survie, adaptation, efficience alimentaire et caractéristiques des carcasses. Compte tenu des différences provoquées par le croisement d'individus d'une même espèce ou d'espèces voisines et de l'évaluation des paramètres génétiques et phénotypiques des traits inhérents à la production de viande, il est possible de procéder à une sélection pour améliorer la production de viande en se basant sur le poids de la bête à l'âge de six mois. De toutes les races indiennes, la Beetal est la préférée en raison de son fort taux de reproduction et sa grande capacité d'adaptation par rapport à la Jamunapari. Son croisement avec les races laitières étrangères provoque, chez cette race, une augmentation du poids et une baisse du taux de reproduction, spécialement des naissances multiples. Parmi les races étrangères qui permettent d'atteindre ce double objectif, l'anglonubienne semble donner un bon rendement. On devra accorder plus d'attention aux races de chèvres indigènes, à leur conservation et à leur exploitation et moins à l'augmentation de leur nombre dans des pays comme l'Inde où leur population est déjà élevée. Cependant, leur taux de reproduction et de survie permet d'augmenter la production de viande sans accroître le nombre de femelles destinées à la reproduction. Ces traits sont très différents selon les croisements. On a proposé certains programmes d'amélioration des chèvres pour la production de viande; toutefois, il est souhaitable de compter les troupeaux des fermiers dans le programme d'amélioration de la race. Les études de troupeau pour choisir les bêtes qui offrent le meilleur rendement moyen selon la race serviront à produire de meilleurs boucs pour les troupeaux. Il est aussi possible de mettre sur pied des programmes de croisement coopératifs à l'aide d'un noyau de mâles et de femelles choisis afin d'obtenir de meilleurs mâles de reproduction pour la production de viande.*

Resumen: *Tomando como base el rendimiento que se obtiene de las cabras de la India, se discuten en este trabajo las características que se relacionan con el rendimiento y que afectan la producción de carne, tales como el crecimiento, el rendimiento reproductivo, la supervivencia, la adaptación, la eficiencia en la alimentación y las características de la canal. Basado en las diferencias dentro de la misma raza y entre las razas y en estimados de parámetros genéticos y fenotípicos de*

características relacionadas con la producción de carne, la selección para el mejoramiento de la producción de carne se puede basar en el peso que tiene el cuerpo de un animal de 6 meses. De todas las razas indias, la de Beetal es la preferida debido a que tiene un gran índice de reproducción y adaptación comparada con la de Jamunapari. El cruzamiento con razas exóticas lecheras mejora el peso del cuerpo, experimentándose un discenso en el rendimiento reproductivo, especialmente en los partos múltiples. De las razas exóticas de doble propósito, la Anglo-Nubia parece tener un buen rendimiento. Existe la necesidad de prestar mayor atención a la conservación y explotación de las razas indígenas de cabras. Menos énfasis se debe hacer en aumentar las cantidades en países tales como la India debido a que el problamiento de estos animales es allí ya muy grande; sin embargo, el índice de reproducción y supervivencia puede aumentar la producción de carne sin aumentar el número de hembras que se pueden criar. Hay grandes diferencias entre estas razas y dentro de la misma raza en lo que respecta a estos rasgos o características. Se propone un número de medidas para mejorar la calidad de las cabras productoras de carne; sin embargo, es deseable que los rebaños de los granjeros participen en programas de mejoramiento de razas. Examinar los rebaños de los granjeros para seleccionar animales con un rendimiento superior al promedio que se ajuste a los parámetros del tipo de raza será útil para producir machos cabríos de calidad superior con el fin de continuar utilizándolos en tales rebaños. También es posible organizar esquemas cooperativos de crianza de grupos con rebaños cuyos núcleos estén formados por machos y hembras seleccionados y utilizar estos esquemas para producir razas superiores de machos para la producción de carne.

Goats make up a large proportion of the domestic ruminants in Asia in terms of number and contribution to meat production. Asia accounts for 54% of the world's goat population and 63% of the world's goat meat production. The contribution of goats to meat production relative to all the other livestock species excluding poultry is 4.6% in Asia and 1.8% in the world. The Asian population of goats from 1979 to 1985 declined by 2.8% (FAO 1985). The major decrease occurred in China; the major increase, in India, where the population increased from 75.6×10^6 in 1977 to 95.3×10^6 in 1982, in spite of a 43% annual removal rate, mainly in the northwestern arid and semi-arid regions.

Factors affecting meat production

Growth (changes in live weight and size), survivability, feed-conversion efficiency (feed consumed per kilogram live weight gain expressed in absolute or relative terms), and carcass yield (dressing percentage) are important economic traits governing meat production. For flocks, reproduction efficiency, age at first kidding, litter size at birth and weaning, milk yield of does, kidding interval, and longevity are factors that must be considered.

Breeds

The majority of goat breeds in India are meat-type animals. Some, like the Jamunapari, Beetal, Jhakrana, and Surti, produce relatively large quantities of milk but are not comparable to the improved dairy goat breeds from Europe and North America. These have been used as improver breeds in India and other Asian countries. Although 20 specific breeds of goats exist in India, approximately 75% of animals do not conform to any breed. Pakistan has 25 breeds of goats (Hasnain 1985) that are used for meat and milk production. In Asia, there are no breeds in the strict sense because there are no breed societies or other government or private agencies that register purebreds on the basis of pedigree, definite physical conformation, and minimum production standards. Although efforts have been made to describe breeds of goats based on physical conformation, little emphasis has been given to production characteristics relative to physical environ-

ment, feeding, or management. More recently, breeds of goats in India and Pakistan have been described not only on the basis of their conformation but also on performance characteristics (Acharya 1982; Hasnain 1985).

Need for better appreciation of indigenous breeds

There is an urgent need for studies on indigenous breeds of goats through elaborate surveys involving flock size and structure, physical environment, feed resources, and management practices. These surveys should be based on proper sampling within the area where the breed is known to be located, flock size, and management. Performance records on reproduction, milk production, growth and survival, as well as specific characteristics related to adaptation and disease resistance are valuable. The surveys should be supported by laboratory studies of gene marker traits that are immunological, biochemical, and cytological in nature. These surveys will enable an assessment of the potential for improvement and need for conservation.

Purebred performance of Indian breeds

The performance of most indigenous breeds of goats is based on limited numbers maintained in institutional flocks. It is difficult to make any interbreed comparisons because of the confounding of breed, feed, and management systems.

Growth

Goat breeds in India can be classified as small, medium, and large: small, Bengal; large, Jamunapari, Beetal and Jhakrana; the rest are medium-size breeds (Fig. 1). Only a few of these breeds have been assessed for meat production. From the available data (Table 1), in the northwest region, Jamunapari is the heaviest, followed by Beetal, Jhakrana, Sirohi, and Marwari. A comparison of Jamunapari, Beetal, Barbari, and Black Bengal at Raja Balwant Singh (RBS) College, Agra, under confinement and stall feeding, although based on small numbers, did not

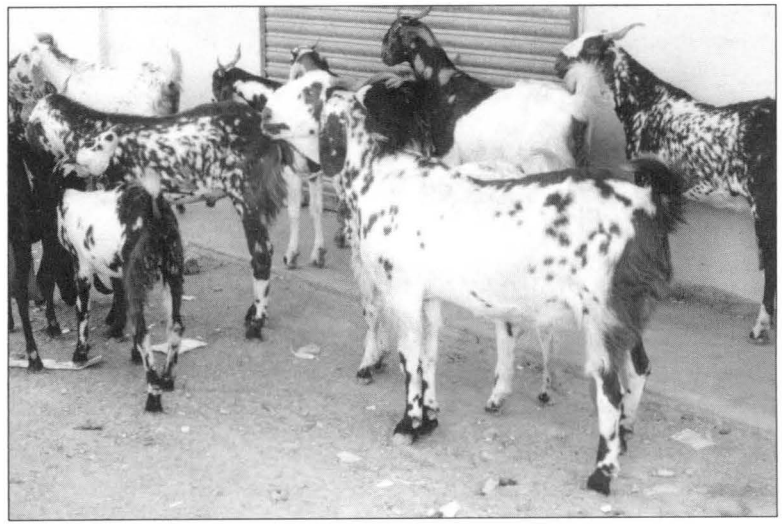

Fig. 1. The medium-size Barbari goat is an outstanding dual-purpose breed in India and Pakistan.

Table 1. Weighted means (±SE) for body weights (kg) of goats at different ages in various regions of India.

Breed	Birth	3 months	6 months	9 months	12 months
			Northwestern India		
Sirohi	2.78±0.02(357)	9.78±0.11(319)	13.49±0.15(204)	17.07±0.17(179)	21.02±0.17(183)
Marwari	2.30±0.04(66)	6.39±0.56(32)	8.70±1.35(14)	13.70±1.58(14)	16.20±1.45(24)
Jhakrana	2.56±0.05(116)	6.93±0.24(45)	10.74±0.47(23)	14.83±0.73(14)	18.01±0.80(13)
Beetal	2.80±0.01(4259)	8.49±0.11(145)	12.44±0.19(116)	16.26±0.42(65)	22.47±0.65(85)
Barbari	1.75±0.01(726)	6.70±0.08(396)	8.74±0.21(50)	12.29±0.40(44)	15.16±0.42(44)
Jamunapari	1.13±0.03(433)	9.86±0.24(49)	11.55±0.52(21)	19.59±0.98(14)	21.84±0.46(29)
			Southern India		
Sangamaneri	1.86±0.00(302)	7.27±0.20(120)	10.06±0.39(52)	13.45±0.14(39)	17.33±2.19(26)
Osmanabadi	2.38±0.01(372)	7.34±0.05(358)	11.07±0.05(211)	15.12±0.24(199)	-
Malabari	1.62±0.01(446)	6.05±0.09(288)	8.84±0.12(253)	11.61±0.14(231)	14.39±0.20(144)
			Eastern India		
Bengal	1.13±0.01(2225)	4.75±0.11(176)	6.81±0.20(74)	9.30±0.36(49)	12.08±0.18(267)
Ganjam	2.30±0.02(342)	-	9.51±0.11(210)	-	11.69±0.15(176)
			Northern India		
Chagu	2.04±0.01(638)	7.52±0.11(436)	10.67±0.17(362)	13.06±0.17(334)	16.89±0.28(228)
Changthangi	2.14±0.05(77)	9.28±0.29(75)	15.94±0.04(76)	15.80±0.16(78)	-

Note: Values in parentheses are the number of observations.
Source: Acharya et al. (1982).

show a superiority of the Jamunapari over Beetal and Barbari (Anon. 1979). The Jamunapari is more sensitive than the other breeds to confinement, stall feeding, and removal from its home tract. A comparison among some of the northwestern breeds of goats carried out at the Central Sheep and Wool Research Institute (CSWRI), Avikanagar, and involving Sirohi, Jhakrana, Marwari, and Kutchi under free-range grazing with little supplementation and confinement showed relatively small differences in growth (AICRP 1985). Jamunapari and Beetal should be used if production is to be increased in medium-size and small breeds. The results of the All-India Coordinated Research Project (AICRP) on Goats at Ranchi show that Beetal, with its good adaptation and reproductive performance, is better in crosses with medium and small breeds. The few breeds in southern India have lower body weights than those of the northwestern region, except for Osmanabadi. In the eastern region, except for Ganjam, which is larger, the Bengal-type goats are smaller and have lower body weights. The breeds in the northern temperate region are also smaller than the breeds in the northwestern region.

Nongenetic factors Year of birth, season of birth, sex, type of birth, litter size, parity, and age and weight of dam at kidding significantly affect birth weight. Weights at later ages were not affected significantly by these factors except for Sirohi, where sex and season of birth were found to significantly affect body weights at all ages.

Genetic and phenotypic parameters The weighted estimates of the heritabilities of body weights indicate that body weights at 6 and 12 months are highly hereditary (Table 2). There are a few reports of phenotypic and genetic correlations among body weights at different ages. Nagpal and Chawla (1987a,b) reported genetic correlations among body weights ranging from 0.27 ± 0.49 to 1.0 in Alpine × Beetal and from 0.40 ± 0.40 to 1.0 in Beetal. The phenotypic correlations among body weights ranged from 0.15 ± 0.8 to 0.88 ± 0.04 in Alpine × Beetal and from 0.20 ± 0.10 to 0.94 ± 0.06 in Beetal. Misra (1983) reported significant but small phenotypic correlations between birth weight and monthly body weight up to 6 months and significant, large correlations among monthly body weights from 1 to 6 months. Genetic correlations were also large and significant, except in the case of birth weight, where they tended to decrease with age. Estimates of genetic and phenotypic parameters are, in general, based on small samples and have large sampling errors. The limited data suggest that body

Table 2. Heritability estimates for body weights at different ages.

Breed[a]	Birth	3 months	6 months	9 months	12 months
Alpine x Beetal (1)	0.27±0.03	0.93±0.12	0.71±0.10	1.00±0.14	0.60±0.09
Beetal (2)	0.24±0.03	-	0.43±0.10	0.86±0.17	0.40±0.16
I x E[b] (3)	0.30±0.11	0.17±0.23[c] 0.10±0.11[d]	0.08±0.10	-	-
Sirohi (4)	0.29±0.16	0.11±0.12	0.32±0.18	-	-
Black Bengal (5)	0.07±0.01	0.15±0.04[d]	-	0.21±0.06	0.32±0.08
Jamunapari (6)	0.46±0.15	0.43±0.15	0.25±0.13	0.13±0.10	0.13±0.17
Pooled h^2	0.11±0.01	0.22±0.03	0.43±0.05	0.33±0.05	0.41±0.05

[a]values in parentheses indicate the source of the data: 1, Nagpal and Chawla 1987a; 2, Nagpal and Chawla 1987b; 3, De Souza et al. 1986; 4, Misra 1983; 5, Gupta et al. 1968; 6, CIRG 1986.
[b]Crosses among descript indigenous (I) and exotic (E) breeds.
[c]60 days.
[d]120 days.

weight at 6 months could be used as a criterion for selection to improve meat production.

Reproductive performance

Information on various aspects of reproduction in indigenous breeds is seriously lacking. There are large inter- and intra-breed variabilities. Because goats breed throughout the year or are bred in more than one breeding season, there are problems in calculating reproductive percentage. In a study on Sirohi kept on free-range grazing only and allowed to breed throughout the year, there were 193 kids born/100 days. In a large flock bred twice a year, there were 90 kids born/100 days. This increase was due to rebreeding (76%) and multiple births (24%). The goats in the two studies were from the same lot and were carried in the same farm (Swain 1984). Of the breeds of the northwestern region, Barbari had the best reproductive performance, although the percentage of multiple births was higher in Beetal, Osmanabadi had a higher kidding percentage, and Malabari had a higher percentage of multiple births. Considering age at first kidding, kidding interval, and percentage of multiple births (Table 3), Bengal had the best reproductive performance.

Phenotypic and genetic parameters The heritabilities of ages at first kidding for Alpine × Beetal and Beetal were reported to be 0.56 ± 0.08 and 0.48 ± 0.09, respectively (Nagpal and Chawla 1987a,b). The heritabilities of litter size were reported to be 0.15 and 0.09 ± 0.25 for Beetal and Black Bengal, respectively (Amble et al. 1964; Moulick et al. 1966). Age at first kidding is highly hereditary and could be included in the selection criteria along with body weight at 6 months.

Survival

The mortality rate is larger in small breeds probably because of low birth weights and large litter sizes. In general, the mortality rate of goats under range conditions and in arid and semi-arid regions with well-drained, sandy soils is lower than that of goats in hot, humid environments. Confinement and stall feeding also result in a higher mortality, possibly because of the greater chances of infection.

Year, season of birth, type of birth, birth weight, and parity all have a significant effect on kid survival. Sex, age, and weight of the dam at kidding do not significantly affect survival. The first 30 days after birth are the most critical and require special management in intensive systems. There are no estimates of heritability of survivability available in goats, but they are probably low and comparable to estimates for sheep (0.04–0.16).

Genetic and phenotypic parameters of feed efficiency

The heritabilities of feed efficiency were 0.23 ± 0.42 and 0.04 ± 0.42 based on dry matter and TDN (total digestive nutrients), respectively. The phenotypic correlations of feed efficiency were low with weaning weight and large and significant with 6-month body weight. The genetic correlations with both body weights, however, were low, although relatively higher with weaning weight (Misra 1983). Considering the low estimates of heritability and inconsistent correlations with body weight, it may be desirable that the selection emphasis be on body weight at 6 months rather than feed-conversion efficiency.

Carcass characteristics

The carcass characteristics of indigenous breeds of goats include preslaughter live weight, hot carcass weight, dressing percentage, and bone percent of animals

Table 3. Weighted means (±SE) for reproductive traits of Indian goats.

Breed	Age at first kidding (days)	Kidding interval (days)	Service period (days)	Kidding (%)	Multiple births (%)			
					Births	2	3	4
Northwest India								
Beetal	743.5±4.8(2387)	364.7±2.3(3626)	169.7±4.4(40)	150.0(38)	40.7(1253)	52.2(1609)	7.0(215)	0.1(5)
Barbari	632.9±26.1(41)	328.7±7.4(32)	124.3±22.2(8)	154.4(322)	49.7(287)	49.3(285)	1.0(6)	-
Jamunapari	735.0±24.0(77)	349.6±5.9(344)[a]	200.6±5.6(376)[a]	79.6(339)	56.2(185)	43.2(142)	0.6(2)	-
Sirohi	776.4±31.3(34)	351.4±18.6(12)	-	82.7(773)	92.9(499)	7.1(38)	-	-
Marwari[b]	676.0±40.2(7)	-	-	91.5(47)	95.3(41)	4.7(2)	-	-
Jhakrana[b]	586.0±51.5(14)	316.0±21.8(3)	170.0±21.7(3)	90.0(60)	89.9(48)	11.1(6)	-	-
Mahrana	-	-	-	-	89.7(27)	10.3(27)	-	-
Gobilwadi	-	-	-	-	84.2(25)	15.8(25)	-	-
Zalawadi	-	-	-	-	82.1(15)	17.9(15)	-	-
Kutchi[b]	782.0±31.7(10)	-	-	84.3(71)	86.4(51)	13.6(8)	-	-
Southern India								
Sangamaneri	550.5±20.9(29)	356.6±5.7(494)	15.5(94)	-	62.8(199)	36.6(116)	0.6(2)	-
Osmanabadi	490.7±11.0(32)	-	-	-	-	-	-	-
Malabari	609.9±15.1(91)	289.7±6.5(482)	142.6±6.7(342)	186.9(103)	49.1(689)	44.2(620)	6.3(88)	0.4(5)
Eastern India								
Bengal	521.8±21.4(38)	282.3±22.7(98)	89.6±15.1(12)	85.0	22.4(154)	54.0(380)	20.9(147)	2.7(19)
Ganjam	1066.9±25.6	376.1±6.7	-	-	-	-	-	-
Northern India								
Chegu	627.9±10.3(236)	279.9±5.3(317)	-	86.4(125)	97.9(426)	2.1(9)	-	-

Note: The values in parentheses are the number of observations.
Source: Acharya et al. (1982).
[a]CIRG (1986).
[b]AICRP (1985).

Table 4. Weighted means (±SE) for some important carcass characteristics of goat breeds in India.

Slaughter age (months)	Slaughter weight (kg)	Hot carcass weight (kg)	Dressing %	Bone %
		Beetal		
5	15.6±1.0(30)	6.7±0.5(30)	42.7(30)	-
9	15.4±0.7(37)	7.7±0.3(37)	49.7(37)	-
12	20.3±4.8(3)	4.3±2.7(3)	46.2(3)	23.2±1.8(3)
		Barbari		
12	19.5±0.6(11)	10.8±0.5(11)	55.4(11)	-
18	21.1±0.5(16)	10.5±0.3(16)	49.9(16)	16.9(16)
		Jamunapari		
6	15.6±1.7(5)	7.4±0.9(5)	44.6(5)	-
9	24.0±1.6(5)	11.6±0.7(5)	48.2(5)	-
12	22.9±0.5(17)	10.4±0.2(17)	45.5(17)	21.3(17)
12	22.5±1.0(4)	10.4±0.4(4)	46.2(4)	19.5±0.7(4)
14.5-18.5	23.4±2.8(5)	11.1±1.5(5)	47.3(5)	-
		Sirohi		
6	13.8±0.3(98)	6.1±0.2(98)	44.0(98)	-
		Bengal		
12	11.6±0.8(8)	5.2±0.4(8)	44.6(8)	23.4±1.8(8)
15-24	16.6±0.6(40)	7.4±0.5(40)	44.5(40)	-
34-39	22.1±1.9(16)	10.3±1.2(16)	46.6(16)	-
		Sangamaneri		
6	9.0(4)	3.7(4)	44.2(4)	-
9	11.5±1.5(5)	5.1±0.7(5)	44.2(5)	-
12	12.6±1.7(4)	5.8±0.5(4)	46.1(4)	-
18	18.0(1)	8.0(1)	44.4(1)	-

Note: The values in parentheses are the number of observations.
Source: Misra (1983).

slaughtered at different ages (Table 4). Dressing percentage ranged from 42.7 to 55.4% across breeds and ages of slaughter. There was an increase in dressing percentage of animals with age at slaughter and it was highest for animals slaughtered at 9 months of age. The bone percent ranged from 16.9 to 23.4%. Of the different indigenous breeds, Barbari, followed by Beetal and Jamunapari, had the highest dressing percentage. Whereas weight at slaughter in Black Bengal and its crosses with Jamunapari and Beetal significantly affected dressing percentage on empty slaughter weight (ESW) and preslaughter weight (PSW), the age at slaughter did not (AICRP 1988). Sex, season of kidding, age and weight at slaughter, and type of feed significantly influence hot carcass weight; however, age and weight at slaughter did not significantly affect the dressing percentage.

Genetic and phenotypic parameters Misra (1983) reported heritability estimates of hot carcass weight and dressing percentage, on both a preslaughter and an empty live weight basis, as well as total bone percentage. The heritabilities of these characters, especially dressing percentage, were large but had large sampling errors. The phenotypic and genetic correlations of hot carcass weight and

dressing percentage were large and positive. Correlations with total bone percentage were large and negative. This indicates that a higher hot carcass weight/dressing percentage will reduce the total bone percentage in the carcass.

Selection for improving meat production

Misra (1983) constructed selection indices based on the estimates of heritability and genetic and phenotypic correlations in Sirohi and Beetal × Sirohi crosses. He observed that the index ($I = X_1 + 1.07X_2 + 0.02X_3$) combining 3-month body weight (X_1), 6-month body weight (X_2), and feed efficiency (X_3) was the most efficient ($R_{IH} = 0.67$). This index will provide maximum improvement in body weight and feed efficiency. To maximize hot carcass weight, Misra (1983) showed that an index combining preslaughter live weight (X_1), body length (X_2), heart girth (X_3), as well as paunch girth (X_4) ($I = -0.15X_1 + 0.06X_2 + 0.17X_3 - 0.04X_4$) is most efficient ($R_{IH} = 0.65$). The results of direct and correlated responses to selection show that selection based only on 6-month body weight would be simplest and will improve 6-month body weight and hot carcass weight. No selection experiments for improving body weight gains, carcass yield, and quality and efficiency of feed conversion appear to have been carried out on goats.

Crossbreeding goats to improve meat production

Crossing among indigenous breeds

Performance studies for milk and meat production of the four important indigenous breeds of goats (Jamunapari, Beetal, Barbari, and Black Bengal) in a 4 × 4 diallele cross under stall feeding and confinement were performed at RBS College, Agra (Anon. 1979). In addition, results are presented from the AICRP on Goats involving crosses of Beetal and Jamunapari with Black Bengal (Table 5) and of Beetal with Sirohi (Table 6). These studies involve age at slaughter, preslaughter live weight, hot carcass weight, dressing percentage, and bone percent. The results showed the usefulness of Jamunapari and Beetal as improver breeds

Table 5. Important carcass characteristics of Black Bengal and its crosses with Jamunapari and Beetal at 9 months of age.

Trait[a]	Black Bengal	Black Bengal x Jamunapari	Black Bengal x Beetal
PSW (kg)	12.97±0.91	13.99±0.75	13.07±1.83
ELW (kg)	10.94±0.82	11.86±0.66	10.10±1.57
Dressed weight (kg)	6.16±0.55	6.72±0.58	6.04±1.08
Dressing on PSW	47.11±1.96	47.21±1.76	45.38±2.96
Dressing on ELW	55.97±2.27	55.74±1.96	55.45±2.99
Carcass components (%)			
Forelimb	20.85±0.76	20.16±0.55	20.49±1.07
Hind limb	21.38±0.87	21.27±0.54	20.03±0.89
Basael	42.89±2.95	43.29±0.94	41.82±0.86
Neck	7.62±1.01	10.58±0.38	10.01±1.44
Liver	4.70±0.57	4.27±0.25	4.84±0.66
No. of kids	13	9	6

Note: Values are means ± SE.
Source: Misra (1985).
[a]PSW, preslaughter weight; ELW, empty live weight.

Table 6. Some carcass characteristics of Sirohi and Beetal x Sirohi male kids under different feeding systems.

Trait[a]	Genotype	Feeding system		
		Range	Range + supplements	Stall feeding
PSW (kg)	Sirohi	13.9±0.9	19.5±1.7	15.3±1.7
	Beetal x Sirohi	15.1±1.3	22.9±1.5	19.4±1.0
Hot carcass weight (kg)	Sirohi	6.2±0.4	9.7±0.8	7.6±0.9
	Beetal x Sirohi	6.4±0.5	11.3±1.0	9.7±0.8
Dressing % on PSW	Sirohi	44.0±1.4	49.8±0.3	49.7±1.4
	Beetal x Sirohi	42.5±0.6	49.1±1.7	49.7±1.9
Bone %	Sirohi	15.9±0.8	13.0±1.5	14.7±0.3
	Beetal x Sirohi	20.5±1.7	14.9±0.8	14.5±0.4

Note: Values are means ± SE.
Source: Misra (1985).
[a]PSW, preslaughter weight.

for medium and small breeds. Beetal is superior because of its better adaptation and higher reproductive performance.

Crossbreeding with exotic breeds

The major studies on crossing indigenous breeds of goats with exotic breeds have been done to improve milk production. The results of such crossings on body weights, reproductive performance, and carcass characteristics (preslaughter live weight, hot carcass weight, and dressing percentage) are presented (Tables 7–9). There were improvements in preslaughter live weight and dressing percentage in Alpine × Beetal and Saanen × Beetal at the National Dairy Research Institute (NDRI), Karnal (Table 9). However, the studies carried out at Haryana Agricultural University, Hisar, involving Alpine × Beetal and Anglo-Nubian × Beetal with individuals kept in an intensive feed lot up to 5 months of age after weaning at 90 days, not only showed improvements in preslaughter live weight and hot carcass weight but also showed a decline in dressing percentage. Of the exotic breeds, Anglo-Nubian merits further study. Anglo-Nubian × Katjang and Saanen × Katjang goats (Wahid et al. 1987) showed improved weaning weights and yearling weights. Average preweaning daily weight gains were not significantly different (60–68 g/day) and postweaning gains were also poor (13–16 g).

Recommendations for increasing meat production

Increasing population

The goat population in most countries is generally large. It is appropriate, therefore, to concentrate more on improving productivity and production efficiency. Reproductive rates and survival must be improved to increase meat production. There are large inter- and intra-breed variabilities in reproduction rates that need to be exploited. There are also many possibilities to improve kid survival through management.

Table 7. Body weights (kg) of exotic x Indian breeds at different ages.

Sire	Dam	Birth	3 months	6 months	9 months	12 months
Beetal	Beetal	2.92±0.05(145)	7.70±0.11(83)	12.18±0.21(78)	-	21.83±0.83(64)
Alpine	Beetal (F_1)	3.19±0.05(553)	10.31±0.13(221)	13.80±0.02(17)	-	40.11±1.75(22)
Saanen	Beetal (F_1)	3.36±0.06(177)	10.42±0.20(51)	14.31±0.53(7)	-	26.87±1.39(14)
Malabari	Malabari	1.69±0.02(228)	5.73±0.12(101)	9.28±0.19(7)	11.09±0.19(70)	15.22±0.42(34)
Alpine	Malabari (F_1)	1.89±0.05(69)	6.31±0.16(35)	8.88±0.36(30)	12.15±0.57(20)	17.64±1.17(7)
Saanen	Malabari	2.30±0.02(188)	6.07±0.11(100)	10.15±0.25(79)	13.27±0.20(72)	17.82±0.50(33)
Saanen	Saanen x Malabari	2.70±0.11(19)	5.90±0.26(6)	9.70±0.52(3)	-	-
Sangamaneri	Sangamaneri	1.86±0.00(302)	7.27±0.28(220)	10.60±0.39(52)	13.45±0.14(39)	17.33±2.19(26)
Angora	Sangamaneri	2.14±0.02(634)	7.25±0.06(407)	10.57±0.09(361)	13.00±0.15(323)	15.97±0.16(260)
Angora	Angora x Sangamaneri	2.19±0.07(649)	8.22±0.09(394)	11.18±0.11(349)	13.41±0.17(219)	15.44±0.21(185)

Note: Values are means ± SE with the number of observations in parentheses.
Source: Acharya et al. (1982).

Table 8. Some important reproductive traits of exotic x Indian goats.

Sire	Dam	Age at first kidding (days)	Kidding interval (days)	Service period (days)	Litter size (%)		
					Single	Twins	Triplets
Beetal	Beetal	534.1±33.8(192)	312.6±6.7(215)	172.7±5.0(308)	40.50(301)	50.59(301)	8.91(53)
Alpine	Beetal (F_1)	495.3±14.0(72)	323.1±4.8(272)	201.2±9.0(109)	58.93(188)	36.05(115)	5.02(16)
Saanen	Beetal (F_1)	546.0±19.0(14)	300.2±10.8(71)	-	66.92(89)	28.57(89)	4.51(6)
Malabari	Malabari	700.0±22.5(51)	295.3±10.2(279)	140.7±8.6(244)	55.01(439)	41.10(328)	3.76(30)
Alpine	Malabari	684.8±26.5(32)	329.4±19.7(30)	183.6±19.2(30)	65.08(41)	34.92(22)	-
Saanen	Malabari	585.3±28.3(18)	406.7±22.8(24)	260.0±63.2(24)	31.25(10)	62.50(20)	6.25(2)

Note: Values are means ± SE with the number of observations in parentheses.
Source: Acharya et al. (1982).

Table 9. Some important carcass characteristics of exotic x Indian goats.

Sire	Dam	N	Age at slaughter (months)	PSW (kg)	HCW (kg)	Dressing
Beetal	Beetal	37	9	15.42±0.65	7.66±0.30	49.68
Alpine	Beetal	30	9	18.31±0.41(18.74)	9.46±0.36(23.49)	51.67(4.00)
Saanen	Beetal	33	9	18.76±0.81(21.66)	9.43±0.44(23.11)	50.27(1.19)
Beetal	Beetal[a]	33	5	15.64±1.02	6.68±0.46	42.71
Alpine	Beetal	13	5	14.07±1.7(-10.04)	5.27±0.83(-21.11)	37.45(-12.31)
Anglo-Nubian	Beetal	22	5	23.90±3.40(53.32)	9.30±1.48(39.22)	38.78(-9.20)
Sangamaneri	Sangamaneri	4	6	9.00	3.71	41.20
		5	9	11.50±1.46	5.08±0.16	44.20
		4	12	12.57±1.68	5.80±0.45	46.10
Angora	Sangamaneri	41	6	12.20±2.37(35.5)	5.08±0.16(36.9)	41.60(1.0)
		35	9	12.85±0.5(11.7)	4.42±0.42(-13.1)	38.40(-13.1)
		27	12	16.49±0.79(31.2)	7.74(33.4)	46.90(1.7)

Note: Values are means ± SE. The values in parentheses are the percentage improvements over the native dam breed. N, number of observations; PSW, preslaughter weight; HCW, hot carcass weight.

[a]Beetal in individual feet lot.

Improving production

There is now little organized breeding activity except in a few central and state governments, which have small breeding farms of important indigenous breeds to produce bucks. Because of the small size of the flocks, the selection and number of superior bucks available does not provide significant superior breeding material. Cooperation with private breeders is necessary and should involve the identification of flocks with a large percentage of animals conforming to the breed type and having relatively better performance.

Superior males and females can be identified on the basis of their 6-month body weights, litter size, milk yield of the dam, and survivability. Such males and females can be used to improve other flocks. This may encourage a large number of superior males to be produced by the flock owners with their own animals. Incentives can be provided in terms of health cover, supplementary feeds, and higher prices for the breeding males produced. The farmers can also be organized to initiate cooperative group-breeding schemes where the selected males and females could constitute a breeding nucleus to produce superior males for distribution among the members. The development departments and universities could also help them in the selection program on an objective rather than subjective basis.

In view of limited organized studies on the institutional farms and under field conditions on improvement of goats through selection, grading, or crossbreeding with exotic breeds, it is necessary that such studies be intensified. Before any new indigenous or exotic breed is introduced, the performance of the indigenous and exotic purebred and the crosses must be evaluated under improved and existing feed and management conditions, including economics of production.

Galal (1987) described stratified milk- and meat-production systems in goats. The first involving a proportion of native does on a range being mated with the males of the same breed for producing replacements. The latter involving the bucks of the improver meat breed and the crossbreeds, both male and female, being raised for meat. In the meat-production system, Galal (1987) proposed that native does on the range be mated to bucks from the same breed to produce replacements, as well as being mated with the improver dairy breed to produce crossbred females. The crossbred dairy females could be mated to improver meat breed bucks and both the male and female crossbred kids could be raised for meat. These schemes are also feasible with large individual flocks and under much better organized situations.

It may be desirable to consider evolving new meat breeds involving superior indigenous and exotic breeds such as Anglo-Nubian. However, more extensive studies on the institutional farms under improved and existing feeding and management conditions must be carried out on the performance of such breeds.

There is little emphasis on supplementary feeding or fattening of kids. Present results indicate that the average daily weight gain could be increased substantially through intensive feeding in addition to range grazing. In addition to improving the productivity of the indigenous breeds through selection, grading, and possible crossbreeding with exotic breeds such as Anglo-Nubian or Boer breeds, efforts should be made to maximize the meat production of the available animals through supplementary feeding. Goat broiler production may become a reality with increased prolificacy and with kids weaned before 2 months of age, intensively fed high energy rations, and slaughtered at 4–5 months. Such a venture

could be taken up commercially in areas with good feed resources and a large meat-consuming market.

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Nutrition and meat production

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Abstract: *Nutritional treatment, especially of dietary protein and energy variables, is the most important environmental factor affecting meat production in goats. The statement is justified by decreasing per caput supplies, a high income elasticity of demand for goat meat, continuing low productivity in goats, and efficiency in the use of the available feed resources. Improved nutrition results in thicker muscle fibres, better developed muscles in the neck, thorax, and fore limb, and greater omental and mesenteric fat depots in goats than in sheep. The plane of nutrition affects the growth of muscles, muscle fibre diameter, chemical composition (protein, fat, and minerals), and total energy deposited in the carcass, amount of fat and its distribution, and time to slaughter weight. The feed-conversion efficiency has a marked influence on the efficiency of meat production. Two important indices of goat meat value are total edible and total commercial proportions, which range from 48 to 72% and 56 to 96%, respectively. These indices must be considered in the context of the economic value of the carcass and noncarcass components of goat meat. The nutritional strategies that merit attention are increased utilization of crop residues, agroindustrial by-products, and nonconventional feeds, increasing the use of dietary nitrogen sources, use of urea–molasses block licks, strategic use of supplementary proteins, and increased cultivation and utilization of proteinaceous forages. These strategies can provide for the more efficient use of feed resources and the application of innovative feeding systems to stimulate increased goat meat production in Asia.*

Résumé: *La nutrition, en particulier les protéines alimentaires et les variables énergétiques, est le principal facteur externe de production de viande chez les chèvres, un énoncé que justifient les approvisionnements décroissants per capita, la forte demande de viande caprine, par ceux dont le revenu est élevé, la constante faible productivité des chèvres et l'efficience de l'utilisation des ressources alimentaires disponibles. Une meilleure nutrition engendre une augmentation du volume de la fibre musculaire, une meilleure musculature du cou, du thorax et des membres antérieurs, et des dépôts de gras omentals et mésentériques plus importants chez la chèvre que chez le mouton. Le niveau de nutrition influe sur la croissance des muscles, le diamètre de la fibre musculaire, la composition chimique (protéines, gras et minéraux), l'énergie totale emmagasinée dans les carcasses, la quantité de gras et sa distribution et le poids à l'abattage. L'efficacité de la conversion alimentaire a aussi une influence marquée sur la production de viande. Il existe deux indices importants de la valeur de la viande caprine : la proportion de viande comestible et la proportion de viande commerciale, lesquelles varient, respectivement, entre 48 et 72 % et entre 56 et 96 %. On doit prendre en considération ces indices suivant la valeur économique de la viande qui provient et de la carcasse et du reste de l'animal. Les stratégies nutritionnelles qui méritent notre attention reposent sur l'utilisation accrue des résidus des cultures, les dérivés agroindustriels, les aliments inhabituels, une plus grande utilisation des sources alimentaires azotées, l'utilisation de blocs d'urée et de mélasse à lécher, l'utilisation stratégique de suppléments protéiques ainsi que la culture et l'utilisation accrues des fourrages protéiniques. Ces stratégies assurent une meilleure utilisation des ressources alimentaires et des systèmes alimentaires innovateurs et, partant, l'augmentation de la production de viande caprine en Asie.*

Resumen: *El tratamiento nutricional, especialmente de proteína dietética y variables energéticas, es el factor ambiental más importante que afecta la producción de carne en las cabras. La afirmación anterior se justifica por la disminución en el suministro per capita, una gran elasticidad en el ingreso en la demanda de carne de cabra, una baja productividad continuada en las cabras, y la eficiencia en el uso de los recursos alimentarios disponibles. Una nutrición mejorada trae como resultado fibras musculares más gruesas, músculos mejor desarrollados en el cuello, tórax, extremidades toráxicas, y un*

omental y depósitos mesentéricos de grasa de mayor tamaño en las cabras que en las ovejas. El plano de nutrición afecta el crecimiento de músculos, el diámetro de fibra muscular, la composición química proteína, grasas y minerales, y la energía total depositada en la canal, la cantidad de grasa y su distribución y el peso en el momento de la matanza. La eficiencia en la conversión del alimento tiene una marcada influencia en la eficiencia de la producción de carne. Dos indices importantes del valor de la carne de cabra son las proporciones comestibles y comerciales totales que van del 48 al 72% y del 56 al 96% respectivamente. Esos índices se deben considerar en el contexto del valor económico de los componentes de la canal y los que no pertenecen a la canal en la carne de cabra. Las estrategias nutricionales que merecen la atención son el incremento en la utilización de residuos de consechas, subproductos agroindustriales y alimentos no convencionales que incrementan el uso de fuentes dietéticas de nitrógeno, el uso de bloques para lamer de urea y molasas, el uso estratégico de proteínas suplementarias y un incremento en el cultivo y utilización de forrajes proteínicos. Estas estrategias pueden llevar a un uso más eficiente de recursos alimenticios y la aplicación de systemas innovativos de alimentación para estimular una mayor producción de carne de cabra en Asia.

The efficient nutrition of goats is the most important factor affecting meat production of developing-country species (Devendra 1987a). This is justified by three considerations. Firstly, the availability of dietary nutrients influences to a large extent the genetic potential of the animal in terms of edible tissues produced. Secondly, feed costs are perpetually increasing and efficient nutritional management implies that the dietary nutrients that are fed can support maximum growth, in which the value of the response is greater than the cost of the feeds utilized. Thirdly, efficiency in the use of the available feed resources assumes that these resources will be used by appropriate animal species, consistent with their dietary needs, capacity, and potential value for meat, milk, fibre, or skin production.

The value of these considerations is particularly compelling in two contrasting situations. In countries such as Pakistan, India, and Bangladesh, chronic feed shortages continuously limit per-animal performance such that many of the important breeds seldom demonstrate high production. By comparison, elsewhere in Southeast Asia, there are abundant sources of fibrous, lignocellulosic materials and nonconventional feed resources, some of which may be fed to goats and converted to meat. Under these circumstances, there is clearly a need for innovative feeding strategies that can provide maximum productivity from goats in Asia. This is especially important in the face of decreasing per caput supplies, increasing demand, and a high income elasticity of demand for the goat meat (Devendra, this issue).

In striving for a high efficiency of production, it is especially important in specific feeding systems aimed at maximizing productivity to maintain an appropriate species, to aim for a realistic potential level of production, to take advantage of the available dietary ingredients, and to identify the objectives clearly in terms of production and profitability. In this, it is particularly important to understand the intrinsic abilities of goats, various aspects of their feeding behaviour, their response to individual environments, and their potential productivity in the context of the efficient utilization of production resources. With specific reference to feed resources, it is equally important to keep in perspective the participation of rumen microorganisms to convert the energy of cellulose, hemicellulose, and other structural carbohydrates, especially coarse fibrous materials, and various nitrogenous compounds, including nonprotein substances like urea and poultry litter, into useful animal products.

This paper emphasizes the special significance of nutrition, its influence on meat production with reference to growth and tissue composition, and some strategies that can be pursued to increase goat meat production in Asia.

Growth

Fowler (1968) described growth to include two aspects: increase in mass per unit time and changes in form and composition resulting from differential growth of the component parts of the body. The process of growth and the physiological factors governing it in young animals also apply to kids. This involves centripetal body growth and successive growth and development of the tissues: bones, muscle, and fat, in that order. However, the tissue compositional characteristics are somewhat different in the kid. This refers particularly to water, lipid, and ash contents, which are lower than in lambs (Gaili 1976).

The nutritional factors affecting growth and meat production have been studied in several breeds in several countries. The pattern obviously varies with breed and environmental factors and is reflected, for example, in the adult body weight of selected breeds of meat goats with a live weight range of 11.2–24.6 kg at 12 months age (Devendra and Burns 1983). These differences are a manifestation of adaptation and function because of the plane of nutrition. Particular reference is made to the studies on the East African goat in Uganda (Wilson 1958a,b, 1960); Katjang goats in Malaysia (Devendra 1966); Barbari and Jamunapari goats (Sengar 1975) and Osmanabadi goats (Gaffar and Biabani 1986) in India; Boer goats in South Africa (Skinner 1972); and Sudan Desert goats (Gaili 1976). These studies, with the exception of those in India, have been recently reviewed by Devendra and Burns (1983).

It is appropriate to refer to the early classical work of Wilson (1958a,b, 1960), who studied the growth and development of kids from birth to slaughter and evaluated the carcasses. Nutritional status had a considerable effect on live weight gain and external measurements. In kids weighing about 2.2 kg at birth, the greatest linear increase was shown by body length; least, by length of the lower hind leg. Sex differences were apparent for all the external measurements studied when the results were compared on the basis of equal age, male kids having significantly larger measurements than female kids. The effect of nutritional regime produced significant differences in all external measurements studied on the basis of equal age and equal weight, with low-plane kids having larger measurements than high-plane kids. A high plane of nutrition had a significant effect on growth rate: high-plane kids reaching 15 kg at approximately 20 weeks; low-plane kids reaching 15 kg after 48 weeks. The sex difference in live weight increased markedly after 16 weeks. Whereas the weekly growth of females slowed to approximately 0.2 kg/head, the males continued at the rate of approximately 0.5 kg/head. The kids showed a marked recuperative capacity when changed from low- to high-plane feeding, indicating the significance of good feeding for growth, even at a later stage.

Muscle

Muscles enable bodily function and their total content and quality are of economic significance. Muscle is also the tissue of primary importance in a nutritional context. The genetic capacity for growth, in particular, the influence of nutrition, has a strong effect on the rates of growth in different muscles. The pattern of growth can in turn influence bodily function and the type of muscular activity.

In comparative studies between goats and sheep, Owen et al. (1978) and Gaili and Ali (1985a) have reported that goats tend to have more carcass muscle

Table 1. Mean fibre diameter (μm) of three muscles from control and fattened Sudan Desert goats and sheep.

Muscle	Sheep		Goats		SE[a]
	Control	Fattened	Control	Fattened	
Semitendinosus	35.8	44.9	37.8	62.5	0.96[a]
Longissimus (lumbar)	32.5	52.8	34.3	60.9	0.62[b]
Biceps brachii	41.7	45.8	45.2	64.7	0.79[b]

Source: Gaili and Ali (1985b). Standard error of the difference between two means.
[a]Standard error of the difference between two means.
[b]Row means differ significantly ($P < 0.05$).

and bone than sheep. Both studies also reported that the muscles of the neck, thorax, and forelimb regions of the goat were better developed than in sheep. However, the back and leg muscles were less developed in goat than in sheep. In all the muscles studied by Gaili and Ali (1985a), goats had significantly ($P < 0.05$) thicker fibres than sheep; the differences between species were more marked in fattened animals compared with the control (Table 1). These results suggest clearly that goats respond more to nutritional treatment than do sheep, since the differences of the results between species were greater for goats than for sheep. Thus, for example, the differences for semitendinosus, longissimus thoracis et lumborum (thoracic part), and biceps brachii muscles in goats were 24.7, 26.6, and 19.5 μm, respectively; the corresponding values in sheep were 9.1, 20.3, and 4.1 μm. When the data for goats were expressed as a percentage of the corresponding fibre diameter of the control animals, the results were 65.3, 77.5, and 43.1%, respectively; the corresponding values for sheep were 25.1, 62.4, and 9.6%. In both species, the longissimus thoracis et lumborum (thoracic part) increased most in fibre thickness and biceps brachii exhibited the lowest increase. Semitendinosus was intermediate.

Fat deposition

Of all tissues, the effects of dietary energy and protein variables are particularly conspicuous on adipose tissue. Breed differences are apparent in the deposition of adipose tissue and perhaps even in the mobilization of the lipids depending on function (meat, milk, or dual purpose) (Table 2). Subcutaneous fat deposition is low and, in any case, occurs late in the growth process. Visceral fat deposition such as renal and mesenteric fat follow later.

The content of adipose tissue is dictated principally by the plane of nutrition, especially the availability of dry matter (DM), level of feeding, and energy and protein contents. Generally speaking, the higher the availability of DM, energy, and protein, the greater the process of growth and deposition of fat. This is seen in the total content of the tissue in the carcass (Table 2) and its distribution (Table 3). Wilson (1960) also demonstrated this point, including the fact that females contained more fat than males.

Between goats and sheep, species differences in the deposition of fat in terms of amount and location are evident. The comparative study of Gaili and Ali (1985a) involving control and fattened animals showed that sheep had less

Table 2. The effect of plane of nutrition on percentage tissue composition in Barbari and Jamunapari bucks slaughtered at 14 months in India.

Tissue	Place of nutrition[a] HH	MM	LL	Significance[b]
		Barbari		
Bones	18.3	18.5	23.1	$P < 0.05$
Muscle	54.3	54.3	61.5	$P < 0.05$
Fat	27.9	28.5	15.4	$P < 0.05$
Total edible	86.0	86.3	82.0	$P < 0.05$
		Jamunapari		
Bones	18.3	18.5	23.1	NS
Muscle	63.4	57.8	55.2	NS
Fat	13.7	19.4	15.7	NS
Total edible	81.7	81.5	77.0	NS

Source: Adapted from Sengar (1975).
[a]HH, high energy, high protein; MM, medium energy, medium protein; LL, low energy, low protein.
[b]NS, not statistically significant.

Table 3. The effect of plane of nutrition averaged carcass measurements (mm) in Barbari and Jamunapari bucks at 14 months in India.

Measurement	Plane of nutrition[a] HH	MM	LL	Significance[b]
		Barbari		
Length of eye muscle	43.8	43.8	35.0	NS
Depth of eye muscle	19.5	21.0	13.0	NS
Back fat thickness	1.4	2.2	1.0	NS
Thickness of fat over ribs	6.8	7.6	2.0	NS
		Jamunapari		
Length of eye muscle	32.7	43.8	30.0	NS
Depth of eye muscle	17.0	20.5	12.0	NS
Back fat thickness	1.0	0.9	1.0	NS
Thickness of fat over ribs	1.0	3.0	2.0	NS

Source: Adapted from Sengar (1975).
[a]HH, high energy, high protein; MM, medium energy, medium protein; LL, low energy, low protein.
[b]NS, not statistically significant.

developed omental and mesenteric fat depots than goats because of an increased response by the latter to deposit fat in these locations (Table 4).

For the same reason that the extent of fat deposition is controlled principally by the plane of nutrition, a poor covering of fat on the carcass is a reflection of inadequate dietary nutrients. This was evident, for example, in the quality of goats slaughtered for meat to serve Madras city in India. The animals came from rural areas with a background of poor nutrition in which no supplements were provided

Table 4. Adjusted mean weight (±SE) and location of fat deposition in Sudan Desert goats and sheep.

Item[a]	Goats		Sheep	
	Control	Fattened	Control	Fattened
Omentum	60±17	190±40	80±25	110±23
Mesenteric fat	72±30	210±20	90±20	130±30
Tail	9±2	11±2	84±60	149±70

Source: Gaili and Ali (1985a).
[a]Weights of omentum and mesenteric fat are adjusted to common empty body weight (18.03 kg) and tail weight is adjusted to left side weight (4.1 kg) along the slopes of the common regression lines.

Table 5. Growth responses of goats to a rice straw diet supplemented with *Leucaena*, rice bran, and molasses in the Philippines.

Diet[a]	Dry matter intake ($g/kg^{0.75}$)	Daily live weight gain (g)	Feed-conversion efficiency
30% RS + 70% L	64.83a	35.7b	12.56b
30% RS + 50% L + 20% RB	71.82a	68.6a	7.65a
30% RS + 50% L + 20% M	70.40a	50.0ab	10.54b

Note: Means followed by a different letter are significantly different ($P < 0.05$). Each diet mean is the average of five replications.
Source: Rasjid and Perez (1980).
[a]RS, rice straw; L, *Leucaena*; RB, rice bran; M, molasses.

(Thulasi and Ayyaluswami 1983). Live goats and sheep from India were preferred in Saudi Arabia for their lean and tender meat as compared with sheep from Australia, presumably on account of the lesser fat content in the carcasses of the former (IIFT 1978). Likewise, Gaili and Ali (1985a) reported a poor deposition of subcutaneous fat in Sudan Desert goats and sheep, which they attributed to the arid environment. It is pertinent to note that there is one practical implication of carcasses with a low content of subcutaneous fat. The evaporative losses could be higher and this must be minimized by better packing and storage of the meat.

Concerning the utilization of available nutrients, the feed-conversion efficiency has a marked influence on the efficiency of meat production. Feed-conversion efficiency is a function of feed composition and the level of feeding relative to maintenance requirements, which, in turn, are dependent on physiological state and maturity. This is evident in the growth response of Philippine goats over 84 days to three types of supplements (*Leucaena leucocephala*, rice bran, and molasses) in a rice straw diet (Table 5).

Effects on carcass composition

Age has a marked effect on carcass composition. In the study of Wilson (1958b), female East African goats were killed at birth and at weights of 4.1, 7.3, 11.3, and 13.6 kg; the carcasses were then evaluated. Since the economic value of the African goat keeper is its meat, edible offal, edible fat, and skin, the dissection

data were grouped to show how these components varied with changed in live weight. The proportion of meat in the live animal increased from 24.5 to 37.5% between birth and 4.1 kg; thereafter, the proportion of meat decreased irregularly to 34.9 at 13.6 kg live weight. The proportion of edible offal fell from 6.4% of the total live weight at birth to 4.8% at 13.6 kg. Edible fat increased from 2.6% at birth to a maximum of 11.3 kg and fell to 8.6% at 15 kg live weight. The proportion of skin fell from 12.4% at birth to 7.2% at 13.6 kg.

In India, a long-term study was undertaken on the effects of the plane of nutrition on Barbari and Jamunapari goats. Three levels of energy and protein (75, 100, and 125%) were used employing the Morrison (1956) recommendations in a total of nine treatments. The main findings of this study relevant to this paper

Table 6. The effect of plane of nutrition on daily growth (g/head) of Barbari and Jamunapari kids in India.

Breed	Plane of nutrition			Significance[b]	
	HH	MM	LL	Energy	Protein
Barbari					
0-6 months	36	33	27	$P < 0.05$	NS
0-14 months	42	38	22	$P < 0.05$	NS
Jamunapari					
0-6 months	44	46	44	-	-
0-14 months	39	41	30	$P < 0.05$	$P < 0.05$

Source: Adapted from Sengar (1975).
[a]HH, high energy, high protein; MM, medium energy, medium protein; LL, low energy, low protein.
[b]NS, not statistically significant.

Table 7. The effect of plane of nutrition on carcass characteristics of Barbari and Jamunapari bucks slaughtered at 24 months in India.

Characteristics	Plane of nutrition			Significance[b]
	HH	MM	LL	
	Barbari			
Live weight at slaughter (kg)	18.7	19.4	11.4	$P < 0.05$
Dressed carcass (%) weight (kg)	9.2	9.7	4.5	$P < 0.05$
Dressing(%)[c]	57.3	58.3	53.7	$P < 0.05$
Edible offals (%)[c]	21.4	20.0	20.6	$P < 0.05$
	Jamunapari			
Live weight at slaughter (kg)	20.3	21.0	15.8	$P < 0.05$
Dressed carcass (%) weight (kg)	9.7	9.8	6.1	$P < 0.05$
Dressing(%)[c]	53.2	53.2	55.5	NS
Edible offals(%)[c]	18.9	20.1	22.9	-

Source: Adapted from Sengar (1975).
[a]HH, high energy, high protein; MM, medium energy, medium protein; LL, low energy, low protein.
[b]NS, not statistically significant.
[c]Expressed as percent of empty live weight.

can be found in Sengar (1975). Growth was retarded and significantly low ($P < 0.05$) with low levels of energy and protein (Table 6). This was manifested in reduced live weight at slaughter, dressed carcass weight, dressing percentage, edible offals as percentage of empty live weight (Table 7), and bone, muscle, and fat composition, especially in Barbari goats (Table 2). The effect of the protein and energy variables on length and depth of the eye muscle, back-fat thickness, and thickness of fat cover on the ribs, however, was not significant (Table 5). Similar results on the carcass characteristics of Osmanabadi bucks have been reported by Gaffar and Biabani (1986). In Mauritius, diets based on sugarcane, sugarcane tops, and *Leucaena* significantly influenced carcass tissues (bone, $P < 0.01$; meat, $P < 0.01$; fat, $P < 0.05$; tendon, $P < 0.001$) in local and Anglo-Nubian goats (Jotee 1984).

Effect on chemical composition

Nutritional treatment has a definite effect on the chemical composition of tissues, notably the protein, fat, and ash contents on Barbari and Jamunapari goats. Gaffar and Biabani (1986) showed that a high dietary energy significantly increased ($P < 0.01$) the fat content, daily energy gain, and total energy deposited in the carcasses of Osmanabadi bucks (Table 8). These results are similar to the situation in Barbari goats (Sengar 1975) and sheep (Andrews and Orskov 1970; Ali 1975). Gaili and Ali (1985b) showed that nutritional treatment and species had a significant ($P < 0.01$) effect on the protein, fat, and ash contents of the muscles of goat and sheep (Table 9). The effect of the nutritional treatment × species interaction was significant ($P < 0.01$) in all muscles for protein and fat but not for ash (Table 10).

Osmanabadi bucks (see Table 8) yielded more protein in the suprapinatus muscle than did sheep. In both the semimembranosus and the longissimus thoracis et lumborum (lumbar part) muscles, control or fattened goats had more protein than both groups of sheep.

Total edible and saleable percentages

The total edible (meat and some offal) and commercially valuable (meat and offals) portions of the carcass are important aspects of the economic value of goats for meat production (Devendra and Owen 1983). They are important indices of value throughout the tropics (Table 11). The total edible portions include the offals, which are valuable for two reasons. First, they are extensively consumed in varying ways. Second, the value of the offals offsets the cost of slaughter.

In most developing countries, the value of meat animal is reflected in the commercial value of the carcass and the cuts that comprise it. The latter refers primarily to he edible components. With reference to goats, the traditional reference to only the carcass and its components is not entirely realistic because, as Table 11 suggests, there are other noncarcass components that are important for edible and commercial reasons. Total fat, for example, is a function of nutritional treatment in terms of the extent of fat deposition, especially in the viscera, and is important in estimations of total edible and total saleable percentages. It is suggested that, so far as goats are concerned, nutritional treatment and growth responses in economic and commercial terms must consider the carcass as well as the total saleable value, including noncarcass components as units of trade.

Table 8. Effect of dietary protein and energy variables on the body composition and nutrient deposition in Osmanabadi bucks in India.

Treatment[a]	Body composition					Total protein deposited (kg)	Total energy deposited (Mcal)	Daily protein gain (g)	Daily energy gain (kcal)
	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Gross energy (Mcal/kg)				
Control	74.1	16.3	4.0	3.4	3.92	1.0	6.35	-	-
LP:LE	67.1	18.8	7.8	4.5	4.78	4.1	34.45	9.7	88.91
LP:ME	66.3	18.7	9.0	4.9	5.09	3.8	34.48	9.7	89.80
LP:HE	62.8	12.7	10.0	2.5	5.38	4.2	41.69	10.0	112.71
HP:LE	65.9	19.6	7.6	4.8	4.68	4.1	33.17	13.3	116.76
HP:ME	65.2	19.9	8.5	5.0	5.49	4.4	41.99	12.3	130.85
HP:HE	61.1	19.6	12.4	5.1	5.93	4.1	48.49	14.5	195.98
SE[b]	1.49	3.85	0.95	0.93	0.33	0.06**	1.39*	0.35	6.34*

Note: 1 cal = 4.19 J.
Source: Adapted from Gafar and Biabani (1986).
[a]LP:LE, low protein, low energy; LP:ME, low protein, medium energy; LP:HE, low protein, high energy; HP:LE, high protein, low energy; HP:ME, high protein, medium energy; HP:HE, high protein, high energy.
[b]Standard error: *, $P < 0.05$; **, $P < 0.01$.

Table 9. Protein and fat contents (%, dry matter basis) of three muscles in Sudan Desert sheep and goats.

Muscle	Sheep		Goats		SE[a]
	Control	Fattened	Control	Fattened	
Semitendinosus					
Protein	88.1a	75.8c	78.6b	64.4d	0.33
Fat	8.2d	21.0c	17.9b	33.4a	0.43
Semimembranosus					
Protein	87.3a	81.2b	75.3c	66.0d	0.39
Fat	9.5d	16.8c	21.8b	31.9a	0.46
Longissimus (lumbar)					
Protein	86.5a	79.1b	75.8c	65.7d	0.28
Fat	10.0d	17.6c	21.4b	32.3a	0.45

Note: Means in a row followed by a different letter differ significantly ($P > 0.05$).
Source: Gaili and Ali (1985b).
[a]Standard error of the mean.

Table 10. Ash content (%, dry matter basis) in three muscles of Sudan Desert sheep and goats.

Muscle	Species			Treatment		
	Goats	Sheep	SE[a]	Control	Fattened	SE[a]
Suprapinatus	3.3	2.8	0.45	3.6	2.5	0.45
Semimembranosus	3.1	2.5	0.27	3.0	2.6	0.27
Longissimus (lumbar)	3.4	2.4	0.32[b]	3.1	2.6	0.32

Source: Gaili and Ali (1985b).
[a]Standard error of the difference between the two means.
[b]The difference between the two means is significant at $P < 0.05$.

Table 11. Total edible and total commercially valuable meats of various breeds of adult goats in the tropics.

Breed (sex)[a]	Location	Total edible (%)	Total commercially valuable (%)	Source
Small East African (F)	Uganda	48.3	55.5	Wilson (1958b)
Katjang(F)	Malaysia	61.2	81.5	Devendra (1966)
Indigenous(M)	Malawi	74.5	80.5	Owen (1975)
Barbari(M)	India	87.6	-	Sengar (1975)
Indigenous(M)	Botswana	72.3	79.6	Owen et al.(1978)
Indigenous(M)[b]	Botswana	71.8	79.2	Owen et al.(1978)
Indigenous(F)	Botswana	74.3	80.9	Owen et al.(1978)
Boer(F)	Botswana	70.0	78.0	Owen et al.(1978)
Katjang(F)	Malaysia	71.5	96.2	Devendra (1980)

[a]F, female; M, male.
[b]Male castrates.

Nutritional strategies

The justification for appropriate nutrition and more attention to efficient nutritional management are associated with the continuing low productivity in goats. It is also justified by the considerable opportunities for applying the recent

advances in goat nutrition. The nutritional strategies that can be pursued for accelerating meat production have been recently discussed (Devendra 1987b,c):

- Increased utilization of crop residues, agroindustrial by-products, and nonconventional feeds;
- Increased use of dietary nitrogen sources;
- Use of urea–molasses block licks;
- Strategic use of supplementary protein sources; and
- Increased forage cultivation and utilization, especially of *L. leucocephala*, cassava (*Manihot esculenta*) leaves, sesbania (*Sesbania grandiflora*), and pigeon pea (*Cajanus cajan*) (Fig. 1).

The basic strategy is to ensure that a sufficient amount of feed from the available resources is available on a year-round basis and can match the requirements of the animals for meat production. Innovative measures and efficient feeding systems in which dietary nutrient supply can be constantly ensured, taking advantage of seasonal surpluses, conservation, and storage practices, are important. Concerning the potential value of cereal straws and other fibrous agricultural residues, options for increasing their utilization by goats have recently been discussed (Trung and Devendra 1987). Urea or ammonia treatment and the use of leguminous forages are particularly promising.

Fig. 1. Woman and children carrying cut fodder for feeding goats in Nepal.

Table 12. Performance of weaner kids in a semi-arid environment in India.

Parameter	B[a]	B+F	B+C	B+F+C
Initial weight (kg)	12.0	12.0	12.7	12.5
Final weight (kg)	13.8	14.7	22.8	22.3
Total weight gain (kg)	1.8	3.7	10.0	9.7
Average daily weight gain (g)	19.4a	41.7b	111.0c	108.2c
Dressing (%)	45.7a	44.5a	48.2b	49.1b
Net return per kid (INR/90 days)[b]	-	9.0	3.6	0.2

Note: Means in the same row followed by a different letter differ significantly ($P < 0.05$).
Source: Parthasarathy et al. (1983).
[a]B, browsing (7 h/day); F, forage; C, concentrates.
[b]In February 1988, 12.2 Indian rupees (INR) = 1 United States dollar (USD).

The strategic use of protein supplements merits special attention because of the high cost of dietary protein. The use of a protein supplement for goat meat production must be carefully considered especially in relation to genotype and potential for growth. The importance of strategic supplementation is seen in the results of a recent study in India. The treatment involved feeding either green forage, concentrates, or green forages and concentrates to browsing weaner kids (Table 12). As would be expected, treatments significantly stimulated daily live weight gains and affected dressing percentages ($P < 0.05$). The net returns indicated that the supplementary feeding with forages gave the highest margin of profits followed by concentrates and the combined treatment. The results emphasize the value of green forages and question the necessity for feeding concentrates for meat production.

The strategy of efficiently using scarce concentrates implies that protein concentrates must be conserved and preferentially utilized, e.g., coconut cake, cottonseed cake, fish meal, groundnut cake, palm kernel cake, soybean meal, and rice bran, all of which are commonly found. Many of these examples are more efficiently used by nonruminants animals; some may even need to be protected for local use rather than be exported.

Conclusions

Meat-production efficiency in goats necessitates that the available feed resources and feeding systems compatible with high production be used. The process of growth and the physiological factors governing it as well as the effects of dietary protein and energy variables on tissue growth in goats are similar to those in other animals. However, as might be expected, species differences exist. Goats appear to have thicker muscle fibres, better developed muscles in the neck, thorax, and forelimb, and greater omental and mesenteric fat depots than sheep. Although traditionally, the carcass and its components are considered in economic and commercial terms as the unit of trade; in goats, in addition to the carcass, noncarcass components and the total saleable components assume economic significance. The opportunity to increase goat meat production is enormous in the context of the more efficient use of production resources and innovative nutritional strategies.

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Reproductive factors affecting meat production

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Abstract: *The lower growth rate and delayed sexual maturity in female kids as a result of poor nutrition and management or diseased results in a poor kid crop, seriously affecting goat meat (chevon) production. An inadequate plane of nutrition and poor hygiene result in delayed age at first heat of 24, 12–14, and 8–11 months in large, medium-size, and small and dwarf breeds, respectively. Age at sexual maturity in female kids can be reduced by 4–6 months for large and medium-size breeds through improved nutrition and prevention of early intestinal infection. An interkidding period of about 210 days is appropriate but is seldom achieved in large or medium-size breeds. The milch breeds (e.g., Jamunapari and Beetal) have an interkidding period of 310–440 days, which can be reduced to improve kid production. Reproductive disorders causing perinatal kid losses can be divided into occasional uterine infection as a result of pyogenic bacteria, early embryonic loss because of* Vibrio foetus *and chlamydial infection, late abortions associated with* Brucella melitensis *and* Mycoplasma *infections, and stillbirths and kid diarrhoea as a result of* Escherichia coli *and coccidiosis. The extent of the losses as a result of these reproductive disorders is estimated at 20–30%. The methods available for the augmentation of kidding rates and for the improvement of lifetime reproductive performance (early sexual maturity, reduced interkidding period, and prevention of reproductive disorders) are discussed. The value of artificial insemination and the wider use of superior bucks are emphasized. Other initiatives such as pregnancy detection using milk or blood, the control of reproductive diseases, regular serological tests for* Brucella *in bucks and does, examination for* V. foetus *infection to reduce the incidence of abortion, vaccination against* Mycoplasma, *and early diagnosis of Johne's disease are essential to reduce perinatal kid mortality. Good hygiene of the sheds used by does in late pregnancy is essential to control* E. coli *and coccidiosis. The application of improved reproductive techniques requires improved feeding and management of does in late pregnancy. Improvement of reproductive performance at the village level is dependent to a large extent on the training of farmers and good extension services.*

Résumé: *Le ralentissement du taux de croissance et le retard de la maturité sexuelle des femelles dus à une nutrition et à une exploitation déficients ou à la maladie entraînent une diminution des portées qui influe sérieusement sur la production de viande de chèvre. Un niveau de nutrition insuffisant et une mauvaise hygiène retardent l'apparition des premières chaleurs de 24, 12 à 14 et de 8 à 11 mois respectivement chez les races de grande taille, de taille moyenne et de taille naine. Une meilleure nutrition et la prévention des infections intestinales en bas âge permettent d'abaisser l'âge de la maturité sexuelle de 4 à 6 mois chez les femelles des races de grande taille et de taille moyenne. Un espacement des mises bas d'environ 210 jours est approprié, quoique rarement atteint chez les races de grande taille ou de taille moyenne. Chez les races laitières (p. ex., Jamunapari et Beetal), la période entre les mises bas est de 310 à 440 jours, mais peut être réduite pour accroître la production de chevreaux. Les troubles de reproduction responsables de la mortalité périnatale sont les suivants : infections utérines occasionnelles causées par une bactérie pyogène, perte hâtive de l'embryon causée par infection à* Vibrio foetus *ou à* Chlamydia *pararickettsiose, avortements tardifs causés par* Brucella melitensis *ou des infections à mycoplasmes, de même que les morts à la naissance et la diarrhée des chevreaux provoquées par* Escherichia coli *et la coccidiose. Le taux des pertes provoquées par ces troubles de reproduction est d'environ 20 à 30 %. Les méthodes existantes pour augmenter le taux de parturition et améliorer la vie reproductive (précocité sexuelle, réduction de l'espace entre les mises bas et prévention des troubles de reproduction) font l'objet de discussions. On insiste aussi sur la valeur de l'insémination artificielle et une plus vaste utilisation de meilleurs boucs. D'autres mesures comme la détection des gestations par*

l'examen du lait ou du sang, la lutte contre les maladies de reproduction, la régularité des tests sérologiques pour détecter la présence de Brucella *chez les boucs et les chèvres, l'examen pour détecter l'infection à* V. foetus *comme moyen de réduire l'incidence des avortements, le vaccin contre le mycoplasme et le diagnostic précoce de la maladie de Johne sont essentiels pour réduire la mortalité périnatale des chevreaux. Le maintien d'une bonne hygiène dans les étables réservés aux chèvres en fin de gestation est essentiel pour lutter contre* E. coli *et la coccidiose. Le recours à de meilleures techniques de reproduction exige d'accorder une alimentation et des soins de meilleure qualité aux chèvres en fin de gestation. L'augmentation du taux de reproduction des chèvres dans les villages est fonction dans une large mesure de la formation des agriculteurs et de la qualité des services de vulgarisation.*

Resumen: *Un indice menor de crecimiento y una madurez sexual retardada en las hembras en su etapa temprana, como resultado de una mala nutrición y una explotación deficientes o enfermedades, trae como resultado la obtención de una reducida cantidad de cabritos, afectando seriamente la producción de carne de caprinos. Una nutrición inadecuada y una higiene pobre originan, con las primeras temperaturas calientes, un retardo en el crecimiento de 24, 12–14 y 8–11 meses en las razas de tamaño grande, mediano y pequeño y enanas respectivamente. La edad de madurez sexual en las cabritas se puede reducir en 4–6 meses para las clases de mediano tamaño a través de una nutrición mejorada y la prevención de infecciones intestinales tempranas. Un período interparto de aproximadamente 210 días es apropaiado pero rara vez se logra con los especímenes de tamaño mediano. Las razas lecheras (por ejemplo, Jamunapari y Beetal) tienen un período interparto de 310 a 440 días, que puede ser reducido para mejorar la producción de cabritos. Los desórdenes reproductivos que causan pérdidas perinatales de cabritos se pueden dividir en infecciones uterinas ocasionales, como resultado de bacterias biogénicas, pérdida embriónica temprana debido al* Vibrio foetus *o infección chlamydial, abortos tardíos asociados con infecciones causadas por la* Brucella melitensis *y la* Mycoplasma, *y partos con el feto muerto y diarrea de cabritos como resultado de la* Escherichia coli *y la coccidiosis. El nivel de las pérdidas como resultado de estos desórdenes reproductivos se estima en un 20–30%. También se discuten aquí los métodos disponibles para aumentar los índices de partos y para mejorar el rendimiento reproductivo de por vida (madurez sexual temprana, período de interparto reducido, y prevención de desórdenes reproductivos). Se enfatiza el valor de la inseminación artificial y un amplio uso de machos cabríos. Otras iniciativas tales como la detección de la preñez utilizando leche o sangre, el control de enfermedades reproductivas, las pruebas serológicas regulares para detectar la brucellosis en los machos cabríos y hembras, el examen para detectar la infección provocada por el* V. foetus *para reducir la frecuencia de abortos, la vacunación contra el* Mycoplasma, *y una diagnosis temprana de la enfermedad de Johne, son esenciales para reducir la mortalidad perinatal en cabritos. Una buena higiene en las cabrerizas utilizadas por las cabras hembras en la preñez tardía es esencial para controlar el* E. coli *y la coccidiosis. La aplicación de técnicas reproductoras mejoradas require una alimentación y explotación mejoradas de las cabras en la preñez tardía. El mejoramiento en el rendimiento reproductivo en la aldea depende en gran medida del entrenamiento de los granjeros y de buenos servicios de extensión.*

Meat is a product of the slaughter of animals. The higher the reproductive efficiency and production of offspring per unit time, the higher the availability of animals for slaughter. Any factor that repressed reproductive rate is obviously detrimental to the meat industry.

Reproductive factors that repress goat meat production

Breeding season and delayed sexual maturity of female kids

Different breeds of Indian goats are believed to have developed through genetic isolation, adaptation, and natural selection with reference to colour, conformation, fertility, and, possibly, taste of meat. Environment plays an important role in developing reproductive traits in recognized breeds. Certain periods of the year and season modulate reproductive phenomena in goats (Prasad and Bhattacharyya 1979). The large and medium-size breeds, e.g., Beetal and most of the northwestern breeds, have a tendency to breed twice during the comfortable

months of the year: February, March, and April and September, October, and November. The Pashmina goats, located 12,000–14,000 ft (3,660–4,770 m) above sea level in the Himalayas, have developed characteristics of kidding only once a year during spring (March, April, or May) befitting the need of the geoclimate. The small and dwarf goats (e.g., Barbari, Black Bengal) reproduce almost year-round (Table 1).

The lower growth rate and delayed sexual maturity of female kids as a result of poor nutrition and management or disease invariably result in a reduced lifetime kid crop and, consequently, a reduced goat meat production. An inadequate plane of nutrition and poor hygiene result in the age of the first heat being delayed to 24, 12–14, and 8–11 months in large, medium-size, and small and dwarf breeds, respectively. Age at sexual maturity of female kids can, therefore, be reduced 4–6 months for large and medium-size breeds by improved nutrition and the prevention of uterine infection.

There are indications that the season of birth has a significant effect on the age of puberty and first kidding. The incidence of multiple births appears to increase with age and reaches a maximum at 5–6 years of age in small and medium-size animals (Bhattacharyya 1982).

Prolonged interkidding period

Ideally, does should be mated within 45–60 days after kidding at the first postpartum heat. An interkidding period of about 210 days should be the target. This target is seldom achieved in large or medium-size breeds. The milch breeds (e.g., Jamunapari, Beetal) often show an interkidding period of 310–440 days (Table 2), which can be reduced to improve lifetime kid production.

Perinatal kid loss

Reproductive disorders causing perinatal kid losses can be divided into occasional uterine infection as a result of pyogenic bacteria, early embryonic loss because of *Vibrio foetus* and chlamydial infection, late abortions associated with *Brucella melitensis* and *Mycoplasma* infections (Dhanda et al. 1959; Pathak 1968), and stillbirths and kid diarrhoea as a result of *Escherichia coli* and *Coccidiosis*. Early embryonic losses can also occur because of thermal stress if mating is induced during the extreme peak of summer. The chronic infection of Johne's disease appears to interfere and the function of endocrine glands (Singh et al. 1986). The loss as a result of all these complications is estimated to be 20–30% (Table 3).

Augmentation of kidding rate and kid protection

Practices that can increase kidding rate are important for meat production. In recent years, methods have been used experimentally for this purpose (summarized in Table 4). It is possible to improve the lifetime reproductive performance of does by promoting sexual maturity, reducing interkidding period, and controlling reproductive disorders associated with perinatal losses.

Superovulation and synchronization of estrus

The normal ovulation rates of large breeds of goats have not been studied adequately. In dwarf goats, the ovulation rate can be as high as 4.0 (Rao and

Table 1. Breeding season and sexual maturity of Indian goats.

Breed	Breeding season	Age at puberty (days)	Age at first conception (days)	Age at first kidding (days)	Source
Barbari	Year-round, winter depression and summer peaks	174±13	344	422	Prasad and Bhattacharyya (1979)
Beetal	Year-round, winter depression and summer peaks	-	375±21	526	AICRP (1985), Misra (1979)
Black Bengal	Year-round, winter depression and summer peaks	150-330	303	450	Ali et al. (1973)
Jhakrana	Feb.-May, Oct.-Dec.	450	-	-	
Jamunapari	May-Nov.		518	643-849	Singh et al. (1986)
Malabari	Year-round, winter depression and summer peaks	437±21	469	616±52	Mukundan et al. (1983)
Sirohi	Feb.-May, Oct.-Dec.	-	-	753.7±11.2	AICRP (1985)

Table 2. Reproductive traits in Indian goats.

Breed	Estrous cycle length (days)	Duration of estrus (h)	Gestation period (days)	First post-partum estrus (days)	Inter-kidding period (days)	Source
Angora	19.4	29.7	145.9±0.8	-	450.1±15.9	Shelton (1961), Marincowitz (1962), AICRP (1985)
Barbari	19±0.4	38±0.9	145±0.3	50.5	238.0	Bhattacharyya (1982)
Beetal	-	24.0	146.6	-	346.5	K.P. Agrawal and A.K. Goel personal communication), Kumar (1978)
Black Bengal	20±1.7	40.5	143.0	61.2	223.8	Ali et al. (1973), Bhattacharyya (1982)
Jhakrana	18.5	29.6	148.1	-	-	K.P. Agrawal and A.K. Goel personal communication)
Jamunapari	17.3	39.1	147.7-148.5	161-223	306-437	Sing et al. (1986), CIRG (1979)
Malabari	-	-	147.1	65.0	299.0	Mukundan et al. (1983), Bhattacharyya (1982)
Sirohi	-	-	146.4	-	359±21	AICRP (1985)

Table 3. Perinatal losses in Indian goats.

Reproductive diseases/disorders	Incidence of infection (%)	Pregnancy loss (%)	Major causes[a]	Source
Uterine infection	17.1	-	*Chlamydia, Mycoplasma, Cornebacterium, E. coli, Pseudomonas*	Singh (1973)
Early abortion, embryonic loss	-	23.3	-	
Late abortion	-	1-1.6	*B. melitensis*	Kulshresta et al. (1978) Pathak (1968)
	20-30	-	*Chlamydia*	Krishna Lal and Rajya (1985)
Stillbirth	-	3-8.3	*Chlamydia*, others	Vihan et al. (1987), Jain (1977), Krishna Lal and Rajya (1985)
Kid loss up to 3 months				
0-1 week	39.3	7.7-18.6	Colibacillosis	Vihan et al. (1987)
1-4 weeks	40.2	11.0-18.3	Colisepticaemia	
1-3 months	10.0	2.2-8.2	*Chlamydia*, coccidiosis, FMD	Singh and Senger (1979), Vihan et al. (1986)

[a]FMD, foot-and-mouth disease.

Table 4. Multiovulation and synchronization agents for goats.

Breed	Agent[a]	Supplier	Dose[a]	Source
		Multiovulation		
Angora	PMSG (Folligon)	Intervet Burns, Omaha, NE, USA	1000 IU	Armstrong et al. (1983a,b), Patil et al. (1984)
	FSH-P (decreasing dose, divided into two at 12-h interval)	Intervet Burns, Omaha, NE, USA	15 and 18 mg	Armstrong et al. (1983a,b)
Barbari	PMSG, PMSG+hCG	Sigma Chemicals, St. Louis, MO, USA	400-1000 IU	Agrawal (1986), Rao and Bhattacharyya (1986)
Black Bengal	PMSG	Sigma Chemicals St. Louis, MO, USA	400-1000 IU	Sinha (1976)
	Audiovisual, olfactory and coital stimuli	-	Stimuli at 36 h postestrus	Rao et al. (1982)
	Oxytocin	-	40 IU	Rao et al. (1982)
		Synchronization		
Angora	Progestagen (in vaginal sponges)	Upjohn, Kalamazoo, MI, USA	60 mg	Armstrong et al. (1983a,b)
	PGF_2^{α} or analogue	-	8 mg, 11 days apart	Otts et al. (1980)
Barbari	MGA	Upjohn, London, U.K.	0.15 mg/goat, 1 day for 15 or 16 days	Agrawal (1987), Rao and Bhattacharyya (1986)
Black Bengal	MGA	Upjohn, London, U.K.	0.15 mg/goat, 1 day for 15 or 16 days	Sinha (1976)
Black Bengal	PGF_2^{α}		11 days apart	Sanwal et al. (1981)
Jhakrana	Progestagen (in vaginal sponges)	Upjohn, London, U.K.	60 mg (medroxy progesterone acetate)	A.K. Goel (personal communication)
Nondescript (local)	PGF_2^{α} analogue	Upjohn, London, U.K.	100-125 g, two doses 11 days apart	Nandy et al. (1987)

aIU, international units.

Bhattacharyya 1980). The ovulation sequence of some of the polyestrous breeds has been studied (Bhattacharyya and Prasad 1974; Rao and Bhattacharyya 1980). With the advent of drugs (PMSG, Gn-RH, and FSH), the induction of superovulation or multiovulation is possible in large flocks of goats. In practice, the minor problems of seasonal depression in goat breeding could be corrected by the synchronization of estrus with the induction of multiovulation (Table 4).

Artificial insemination and frozen semen technology

For a flock of three to five goats, the farmers often do not prefer to maintain a buck. They usually depend on sharing one or two bucks in the village, maintained by a flock owner who may have 10–15 does. These bucks are seldom managed properly and are often subfertile. There is a great demand for fertile, tested bucks among farmers. No government agency is presently undertaking a progeny-testing program for the production of superior bucks for farmers in India; neither is there any farm for rearing bucks with superior genetic merit. Obviously, the value of artificial insemination and the wider use of a limited number of superior bucks is essential. Table 5 provides a comprehensive summary of recommended protocols for artificial insemination in goats using freshly diluted and frozen–thawed semen.

Early detection of pregnancy

In the villages, farmers have no means of detecting pregnancy early and often miss the opportunity to promptly mate the does. This delays conception and the interkidding interval. ELISA tests can be introduced in the field to successfully detect pregnancy using milk or blood as biological materials.

Possibility of year-round breeding

To avoid kid mortality, farmers of northern India often avoid kidding during the peak of winter and summer and, in this way, restrict the annual kidding rate. Dwarf breeds (e.g., Black Bengal) have the potential to breed twice a year; medium-size breeds, at least twice in 14–16 months. Year-round kidding would, however, be beneficial if kids were protected against the adverse weather of the winter and the summer. The continuous, year-round availability of fertile bucks with the flocks at the village level is the only answer because artificial insemination and frozen semen technology cannot be easily practiced.

Control of reproductive diseases

Regular serological tests for *Brucella* in bucks and does, examination for *V. foetus* infection to reduce the incidence of abortion, vaccination against mycoplasma, and early diagnosis of Johne's disease are needed to reduce perinatal kid mortality. Proper hygiene of the sheds for does in late pregnancy and during kidding is essential, as is the clinical control of *E. coli* and coccidiosis in the flock.

Practical problems and constraints

There are several opportunities for improving the reproductive efficiency of goats for meat production. However, there are serious practical problems concern-

Table 5. Recommended method for artificial insemination with freshly diluted and frozen-thawed semen in goats.

Fresh semen[a]	Frozen semen[b]
° Select and train bucks for artificial vagina collection	° Select and train bucks for artificial vagina collection
° Collect semen on alternate days	° Collect semen on alternate days
° Evaluate semen for volume, motility, sperm density, percent live, and abnormal spermatozoa	° Evaluate semen for volume, motility, sperm density, percent live/dead, and abnormal spermatozoa
° Good ejaculate should contain: volume, >0.3 mL; motility, +5; sperm density, >3000 x 10^6; percent live, >80%; percent abnormal, <10%	° Good ejaculate should contain: volume, >0.3 mL; motility, +5; sperm density, >3000 x 10^6; percent live, >80%; percent abnormal, <10%
° Dilute semen in processed goat or cow milk at 60 x 10^6 live, normal spermatozoa per inseminating dose (0.1 mL)	° Dilute the semen in Tris diluent at 80 x 10^6 live and normal spermatozoa in 0.1 mL diluted semen
° Inseminate does in estrus within 2-3 h of collection and dilution; locate the opening of cervix; deposit the semen with inseminating pipette on the opening of the cervix	° Equilibrate glycerolized semen for 4 h at 4-7°C
	° Freeze the straw horizontally in liquid nitrogen vapour for 10 min at a temperature from -50 to -170°C
° Note: Expect overall fertility rate with one insemination in each estrus in three consecutive cycles, 70-80%; storage beyond 8 h at 4-7°C gives poor sperm motility and fertility	° Plunge the frozen straw into liquid nitrogen (-196°C)
	° Postfreezing evaluation is done by thawing straw directly at 4°C for 1 min
	° Inseminate does in estrus after assembling the inseminating gun with thawed straw and sheath; locate opening of the cervix and deposit semen with the help of inseminating gun on the opening of the cervix
	° Note: Expected overall fertility rate with frozen semen and double insemination in one estrus, 30-40%

[a]Source: Tiwari et al. (1968).
[b]Source: Tiwari and Bhattacharyya (1987).

ing the use of improved methods and the transfer of knowledge to farmers at the village level.

Distribution pattern of goats in the country

The goat industry in India depends on the rearing of goats by many farmers below the poverty line and the distribution of products throughout the country. Economic constraints discourage the wide application of known reproduction technology. The problem is associated with farmers who have no resources and

access to common grazing lands. The application of any improved reproduction technique will require supplementary feeding and improved management of the does.

Lack of farmer training

Many farmers have a limited knowledge about the sequence of events in the reproduction of goats other than the detection of heat from spontaneous bleating, mounting behaviour, and mucous discharge. This deficiency results in repeated services and prolonged interkidding periods. The care and management of does in late pregnancy is often neglected because of ignorance, resulting in abortions not caused by infections. Training of farmers at the village level would obviously be beneficial.

Availability of reproduction data

The farmers do not have the urge or incentive to record reproduction data, which is essential to maintain high reproductive efficiency. This situation must be improved so that the reproductive potential of the goat population may be achieved.

Availability of health care

At the village level, there are hardly any specialists who can help with problems of reproduction in goats. Also, the veterinarians or other subordinate staff are inadequate to handle problem cases in the villages.

Proven bucks and artificial insemination

The establishment of frozen semen banks and a chain of artificial insemination centres for goats in the country is necessary to ensure improved meat production in goats.

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Disease factors affecting goat meat production

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Abstract: *There is a variety of infectious diseases leading to abortion and embryonic losses in goats causing decreased meat production; the infectious organisms include* Brucella melitensis, Chlamydia, Leptospira, *and* Mycoplasma. *Neonatal losses as a result of* Escherichia coli, *foot-and-mouth disease, and coccidial infection are considered to be significant; the total losses caused by these infections are estimated at 20–30%. Insidious diseases such as* Mycobacterium paratuberculosis *and internal and external parasites influence growth, weakening and stunting the animal. Organs like the liver, lungs, heart, and brain are frequently rejected and condemned because of the invasion and migration of parasites in affected goats. Communicable diseases such as tuberculosis, brucellosis, chlamydiosis, hydatidosis, cysticercosis, and taeniasis adversely affect meat production, as do slow viruses like Visna/Maedi and Jaagsiekete. These diseases can be controlled. Regular testing for brucellosis and Johne's disease and the elimination of infected animals will help reduce the incidence of diseases. Besides clinical control of* E. coli *and coccidiosis, proper hygiene in the sheds and ensuring colostrum feeding are of paramount importance. The determination of worm load and the use of suitable drugs in infected goat flocks is the simplest way of controlling parasitic infestations. A field ELISA test can be introduced to successfully detect many diseases, particularly subclinical infection of* M. paratuberculosis. *It is essential that diseases affecting meat production in goats be combated, laboratory facilities be improved, and the availability of trained personnel and diagnostic antisera/antigen be increased.*

Résumé: *Il existe une grande variété de maladies infectieuses responsables de l'avortement et des pertes d'embryon chez les chèvres et, partant, d'une baisse de la productivité; mentionnons les infections à* Brucella melitensis, *à* Chlamydia, *à leptospires et à mycoplasmes. La mortalité néonatale causée par* Escherichia coli, *la fièvre aphteuse et les infections à coccidies est considérée comme élevée; ces infections, estime-t-on, présente un taux de 20 à 30 %. Les maladies insidieuses comme celle engendrée par* Mycobacterium paratuberculosis *ainsi que les parasites internes et externes contribuent à affaiblir l'animal et retarder sa croissance. Il est fréquent que les organes, comme le foie, les poumons, le coeur et la cervelle soient rejetés et condamnés parce que les parasites avaient infesté les chèvres malades. Les maladies transmissibles comme la tuberculose, la brucellose, la chlamydiase, l'hydatidose, la cysticercose et la téniase nuisent à la production de viande de la même façon que les virus lents comme Visna/Maedi et Jaagsiekete. Il s'agit là toutefois de maladies que l'on peut vaincre. La régularité des tests pour dépister la brucellose et la maladie de Johne et l'élimination des bêtes infectées contribueront à réduire l'incidence de ces maladies. Outre le contrôle clinique de* E. coli *et de la coccidiose, le maintien d'une bonne hygiène dans les étables et l'ingestion du colostrum par le nouveau-né sont d'une extrême importance. La détermination du fardeau parasitaire et l'utilisation des bons médicaments pour traiter les troupeaux caprins infectés sont la meilleure façon d'enrayer les infestations parasitaires. L'utili-sation place du test ELISA permet de détecter nombre de ces maladies, en particulier l'infection inapparente à* M. paratuberculosis. *La lutte contre ces maladies caprines, qui ont des répercussions sur la production de viande, l'amélioration des laboratoires, de même que l'augmentation du nombre d'employés formés et la production d'anti-serums ou antigènes diagnostiques sont des mesures essentielles à prendre.*

Resumen: *Hay una variedad de enfermedades infecciosas que conducen al aborto y las pérdidas embriónicas en las cabras. Entre estas infecciones se encuentran las causadas por la* Brucella melitensis, *la* Chlamydia, *la* Leptospira, *y la* Mycoplasma. *Las pérdidas neonatales como resultado de la*

Escherichia coli, *la fiebre aftosa y la infección causada por la cocidial, se consideran como infecciones significativas y su nivel de incidencia se estima que sea de un 20 a un 30%. Enfermedades insidiosas tales como la Mycobacterium paratuberculosis y los parásitos internos y externos ejercen influencia sobre el crecimiento, debilitando y atrofiando al animal. Organos como el hígado, los pulmones, el corazón y el cerebro se rechazan con frecuencia y decomisan debido a la invasión y migración de parásitos que han tenido lugar en las cabras afectadas. Las enfermedades transmisibles tales como la tuberculosis, brucelosis, clamidiosis, e hidatidosis, cisticercosis y la taeniasis afectan negativamente la producción de carne, así como los virus lentos como el Visna/Maedi y el Jaagsiekete. Estas enfermedades se pueden controlar. La realización de pruebas regulares para detectar la presencia de brucelosis y la enfermedad de Johne y la eliminación de los animales infectados ayudarán a reducir la frecuencia de enfermedades. Además del contro clínico sobre el* E. coli *y la coccidiosis, es de suma importancia mantener una higiene apropiada en las cabrerizas y asegurarse de que los animales reciban una alimentación rica en colostrum. Determinar la existencia de lombrices y usar los medicamentos adecuados en los rebaños de cabras infectadas es la manera más simple de controlar las infecciones parasitarias. Una prueba ELISA sobre el terreno se puede introducir para detectar exito-samente muchas enfermedades particularmente la infección subclínica de* M. paratuberculosis. *Es essencial combatir las enfermedades que afectan la producción de carne en las cabras, mejorar las instalaciones de laboratorio, la disponibilidad del personal entrenado y aumentar la frecuencia del diagnóstico antisera/antígeno.*

The goat meat industry in India is mostly managed by the illiterate and poor. Farmers do not know enough about goat husbandry, particularly goat diseases. The occurrence of various infectious diseases in goats has been reported in different age groups (Singh et al. 1974, 1975; Jain 1977; Kulshresta et al. 1978; Krishna and Rajya 1985; Singh, Singh et al. 1987; Vihan et al. 1987; Vihan and Singh 1988). Disease factors play a vital role in the retardation of body growth (Singh, Vihan et al. 1987; Vihan et al. 1987; Vihan and Singh 1988). The diseases of zoonotic importance are tuberculosis, *Brucella melitensis*, chlamydiosis, coenuriosis, etc. (Pathak 1968; Paliwal et al. 1971; Rao 1971; Charan et al. 1973; Jain et al. 1975). These diseases render the goat meat unsuitable for human consumption.

Abortions and embryonic losses

There are many disease factors that are responsible for causing abortions and embryonic losses in goats. *Chlamydia, Leptospira, Mycoplasma,* and *B. melitensis* are the main factors responsible for abortion in late pregnancy (Table 1). Pathak (1968) and Kulshresta et al. (1978) reported 1–1.6% in losses as a result of *B. melitensis*. A high incidence of *Chlamydia* infection (20–30%) associated with abortion has been reported in goats (Krishna and Rajya 1985). *Mycoplasma (M. agalactiae, M. oculi, M. arginini,* serogroup 11) has been associated with inflammatory conditions of female genital tract and abortion in goats (Dhanda et al. 1959; Pathak and Singh 1984; Singh et al. 1975; Tiwana et al. 1984). The prognosis of *B. melitensis* infection is poor: eliminationis the only solution. Antibiotics can be used in the preliminary stages of *Chlamydia* and *Mycoplasma* infection in goats.

Neonatal kid mortality

Stillbirths and neonatal mortality present problems to goat meat production, particularly under intensive management conditions. Neonatal losses can be separated into four groups: stillbirths as a result of *Chlamydia* infection, young mortality as a result of *Escherichia coli* infection (colisepticemia, colitoxemia, colibacillosis), foot-and-mouth disease, and coccidial infections (Shrama and Dutt

Table 1. Causes of abortion and embryonic loss in Indian goats.

Disease	Cause	Incidence of infection (%)	Pregnancy loss (%)	Source
Early embryonic loss	-	-	23-29	Achuthankutty and Raja (1971)
Late abortion	*B. melitensis*	2.15	1-1.6	Pathak (1968), Kulshresta et al. (1978)
	Chlamydia	20-30	7.9	Jain (1977), Krishna and Rajya (1985)
	Mycoplasma	17-18.1	-	Singh (1973), Tiwana et al. (1984), Singh et al. (1974, 1975) Pathnak and Singh (1984)
	Leptospira	-	-	Upadhye et al. (1980)
Stillbirth	*Chlamydia*	-	3-8.25	Jain (1977), Krishna and Rajya (1985)

Table 2. Neonatal mortality (%) as a result of various diseases.

Disease	Incidence (%)	Mortality (%)	Source
Colibacillosis + colisepticemia	39.3-60.0	5.4-19.0	Vihan et al. (1986), Vihan et al. (1987) Vihan and Singh (1988)
Chlamydia	-	62.8	Krishna and Rajya (1985)
Coccidiosis	12.0-32.3	5.1-12.3	Vihan et al. (1987)
Foot-and-mouth disease	-	3-16	McVicar and Sutmoller (1972), Singh, Vihan et al. (1987)

1968; Bhatia and Pande 1969). The incidence of *E. coli* infection in kids up to 30 days old was 39.3%; mortality, 5.4–19.0% (Vihan et al. 1988). The mortality in the preweaning stage varied from 8 to 72% (Table 2) (Bhat 1988).

Neonatal mortality can be prevented by improving the level of nutrition in advanced stages of pregnancy, ensuring hygienic conditions in the kidding sheds, providing proper bedding, and ensuring early feeding of colostrum. The monoclonal antibodies derived from the caprine species are desirable for therapeutic purposes for intestinal infections, particularly in the treatment of neonatal kid diarrhoea caused by *E. coli*.

Chronic diseases in adult goats

Gastrointestinal infections (coccidiosis, *Mycobacterium paratuberculosis* and internal gastrointestinal parasites (haemonochosis, tapeworm, and immature amphistomiasis) are common in goats maintained in confinement and when assembled from a wide variety of sources. These diseases of the digestive tract influence growth, weaning and stunting the animal (Mukherjee 1963; Shastry and

Ahluwalia 1972; Singh, Vihan et al. 1986, 1987). The internal and external parasites generally render the infected goats weak and anemic because of their constant feeding on host tissues. The absorption of essential nutrients is greatly interfered with, causing malnutrition. The determination of worm load and the use of suitable drugs in an infected goat flock is the simplest way to control parasitic infestations (Table 3). The prognosis of chronic infections like *M. paratuberculosis* is poor and elimination is the only solution. The extent of the loss in meat production because of these diseases is not known.

Slow-growing viruses

Slow-growing viruses like Visna/Maedi and Jaagsiekete occur in Indian goats, causing death and damaging the respiratory system. The viral disease of the lentivirus group is caprine viral arthritis encephalitis syndrome (CAE). This disease has been reported in a few Asian countries (Singh 1988), particularly Thailand. The prognosis of this disease is bad.

Contamination of goat meat

Valuable organs like the liver, lungs, heart, and brain are frequently damaged because of the invasion and migration of parasites. Fascioliasis in goats is an important disease that reduces the value and extent of meat production in goats (Arora and Iyer 1966; Gill et al. 1983). Other parasites include hydatid cysts and coenuriosis, which directly damage the meat and indirectly affect goat production. The prognosis of fascioliasis is good if effective drugs are given at the right time. The prognoses of both hydatidosis and coenuriosis are bad; slaughter is the only answer. Improved serodiagnostic tests are needed for detection of hydatidosis in goats.

Zoonotic disease factors

The evidence of zoonotic diseases occurring in goats is fairly common in India (Pathak 1968; Rao 1971; Charan et al. 1973; Jain 1977). These diseases can infect man and include tuberculosis, brucellosis, chlamydiosis, hydatidosis, and cysticercosis/taeniasis; all adversely affect meat production. To improve the quality of meat, proper carcass inspection in the slaughterhouses is necessary. Because of the frequency of these diseases in goats, it is recommended that legislation on meat-inspection measures be strengthened.

Problems and constraints to preventive health

Several new vaccines and other preventive measures have recently become available. The implementation of new preventative measures in a country like India requires an infrastructure of facilities at the village level. There is a paucity of trained labour in India and most of the problems of goat farmers remain unidentified and unsolved. This is partly due to an overemphasis on the health of cattle and inadequate exposure to goat diseases.

Table 3. Preventive measures for parasitic infestation.

Disease	Causative agent	Drug and dosage	Remarks
Fascioliasis	*Fasciola gigantica*	Zanil, 1 mL/3 kg BW	100% effective
	Fasciola hepatica	Trodex, single dose injection, 1 mL/40 lb BW	90-100% effective
	Dicrocoelium dendriticum	Hexchlorophane, 15 mg/kg, BW in alcoholic solution	Effective and non-toxic
Immature amphistomiasis	*Paramphistomum cervi*	Neguvon, 50-70 mg/kg BW	94% effective
	Cotylophoron cotylophorom	Hexachlorethane, 1 mg/2 kg BW	50% effective
Nematodiasis	*Haemonchus contortus*, *Ostergia* spp.	Nilverm, 15 mg/kg BW	Safe and effective
	Trichostrongylus colubriformis, *Cooperia* spp.	Thiabendazole, 50 mg/kg BW	
	Strongylodoides, *Bunostomum*, *Trignocephalum*	Fenbendazole, 50 mg/kg BW	90-95% effective, 2 or 3 times/year
Monieziosis	*Moniezia expensa*, *Moniezia benedeni*	Yomesan, 75 mg/kg BW	
	Avitellina spp., *Stilesia* spp.	Lead arsinate, 0.5-1 g in gelatin capsule	
Mange	*Sarcoptes scabiei*, *Psoroptes* spp.	0.4% dipping with Cythion or Melathion	2 or 3 times/year

[a]BW, body weight; 1 lb = 0.454 kg.

Diagnostic facilities and immunobiologicals

Disease prevention and efficient health control require adequate laboratory facilities and diagnostic antisera and antigens. There is also a need to develop an early diagnostic test to detect subclinical cases of *M. paratuberculosis* in goats. Disease-monitoring and surveillance systems have not been developed in most Asian countries.

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The influence of sex on goat meat production

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Abstract: *Goats have a number of characteristics, such as high reproductive potential, ability to thrive on shrubs, bushes, and tree leaves, and less susceptibility to infectious diseases, that make them suitable as meat-producing livestock in developing countries. Males grew faster than females and, generally, the progeny of large breeds grew faster than the progeny of small breeds. Cross-breeding larger with smaller breeds achieved faster growth rates in the progeny. Castrates grow faster than entire males, irrespective of the method of castration (open or emasculation). Limited work suggests that 1-month castrates grew significantly faster ($P < 0.05$) compared with intact animals. The dressing percentage is generally lower in females than in males and increases with increased body weight. Higher planes of nutrition improved weight gains and dressing percentage. One-month castrates yielded significantly higher carcass weights ($P < 0.05$) compared with intact animals under identical conditions of feeding and management. In yearlings, lean meat and fat contents in the carcass varied from 62 to 65% and from 6.9 to 17.4%, respectively. Lean meat to bone ratios varied from 2.7:1 to 3.6:1. The area of eye muscle increased with increased body weight and this was accompanied by a decrease in bone content.*

Résumé: *Les chèvres présentent certaines caractéristiques — fort potentiel reproductif, aptitude à se nourrir d'arbustes, de buissons et de feuilles d'arbres, plus grande résistance aux maladies infectieuses — qui en font de bons animaux à boucherie dans les pays en développement. La croissance des mâles est plus rapide que celle des femelles et, en général, la croissance de la progéniture des races de grande taille, plus rapide que chez celles de petite taille. L'hybridation de races de grande de taille et de races de petite taille hâte la croissance de la progéniture, tout comme la castration accélère passablement celle des mâles, quelle que soit la méthode utilisée (castration ouverte ou émasculation). Malgré leur portée limitée, certains travaux suggèrent que chez les chèvres châtrées à un mois la croissance est plus rapide ($P < 0,05$) comparativement aux bêtes non castrées. Le rendement à l'abattage est généralement inférieur chez les femelles et proportionnel à l'augmentation du poids. Des niveaux de nutrition plus élevés ont permis des gains de poids et un rendement à l'abattage supérieurs. Les chèvres châtrées à un mois ont présenté des carcasses d'un poids supérieur ($P < 0,05$) comparativement aux bêtes non castrées qui ont reçu une alimentation et des soins identiques. Chez les chèvres âgées d'un an, la quantité de viande maigre et de gras des carcasses est de 62 à 65 % et de 6,9 à 17,4 % respectivement. Quant au rapport entre la quantité de viande maigre et d'os, il s'échelonne entre 2,7 pour 1 et 3,6 pour 1. L'étendue des muscles oculaires augmente avec le poids du corps et est accompagnée d'une diminution du contenu en os.*

Resumen: *Las cabras poseen unas características como alto potencial reproductor, habilidad para sobrevivir alimentándose de arbustos, malezas y hojas de árboles y son menos susceptibles de contraer enfermedades infecciosas, características que las hacen más apropiadas como ganado productor de carne en países en desarrollo. Los machos crecieron con más rapidez que las hembras y, generalmente, la prole de razas grandes creció con mayor rapidez que la de razas pequeñas. El cruzamiento de razas grandes con pequeñas logró índices de crecimiento más rápidos en la prole. Los machos castrados crecieron con mayor rapidez que los machos enteros, independientemente del método de casración (abierto o de emasculación). Un trabajo limitado sugiere que los animales castrados de un mes crecieron significativamente con mayor rapidez ($P < 0,05$) comparado con los animales que no fueron castrados. Los rendimientos de la canal son generalmente más bajos en las hembras que en los machos y aumenta con el peso. Una nutrición superior mejoró las ganancias de peso y los rendimientos de la canal. Los animales castrados de un mes arrojaron pesos de la canal significativamente más altos*

(P < 0,05) comparados con animales no castrados bajo condiciones idénticas de alimentación y explotación. En los corderos, la carne magra y los contenidos de grasa en la canal variaron de 62 a 65% y de 6,9 a 17,4% respectivamente. Las relaciones entre la carne magra y los huesos variaron de 2,7:1 a 3,6:1. El área del músculo motor aumentó con el incremento del peso y esto estuvo acompañado por una disminución en el contenido del hueso.

The majority of goats in Asia are found on the Indian subcontinent (Bangladesh, Bhutan, India, Nepal, Pakistan, and Sikkim). In terms of meat production, of the 1.9×10^6 t of goat meat produced per year worldwide, approximately 74% comes from tropical countries with 34% from India (Devendra and Owen 1983). In Asia, where landholdings are small and the purchasing power of the farmer is limited, goats are the animal of choice for meat and milk, especially for small, marginal farmer communities because the goat maintains itself on tree leaves or shrubs, thrives in a wide range of ambient temperatures, is less susceptible to infectious diseases like tuberculosis, and produces highly palatable lean meat; it is also highly productive compared with other ruminants, being a prolific breeder. There is considerable potential for increasing goat meat production, especially because the demand for animal protein far exceeds supply in many Asian countries.

Growth rates

One of the major influences on the growth of goats is the mature size of the sire and the dam. The mature size of goats varies from 15 kg for small Bengal breeds to over 75 kg for Jamunapari goats. Generally, the progeny of large breeds are heavier at birth and grow faster than the progeny of small breeds (Table 1). Because one of the means of increasing the contribution of meat from goats is the greater exploitation of available genetic resources (Devendra 1987), especially meat breeds in Asia, large breeds of goats have been crossed with smaller breeds

Table 1. Birth weight of common breeds of goats and their growth rates.

Breed	Sex[a]	Birth weight (kg)	Mature weight (kg)	Growth rate (g/day)[b]	Source
Jamunapari	M	3.57	75.90	93	Senger (1978)
	F	2.78	60.70	64	
Bengal	M	1.10	19.30	31	Senger (1978)
	F	0.98	13.22	20	
Katjang	M±F	1.50	25.30	56	Devendra (1966)
Beetal	M	3.04	60.75	90	Joshi (1979)
	F	2.96	45.50	49	
Barbari	M	1.83	30.40	40	Joshi (1979)
	F	1.61	25.35	33	
Malabari	M	1.61	25.35	41	Nair (1979)
	F	1.59		35	
Alpine x Beetal	M	3.20	-	124	Mishra (1979)
	F	3.14	-	59	
Saanen x Beetal	M	3.56	-	112	Mishra (1979)
	F	3.18	-	58	
Alpine x Malabari	M	1.84	-	52	Nair (1979)
	F	1.68	-	38	
Saanen x Malabari	M	2.05	-	49	Nair (1979)
	F	1.89	-	42	

aM, male; F, female.
bBirth to 12 months.

to achieve faster growths. Cross-breeding of Beetal with Alpine and Saanen revealed a nearly twofold improvement in growth rates over a 12-month period in Alpine × Beetal and Saanen × Beetal males (Table 1). Likewise, Alpine × Malabari and Saanen × Malabari showed improved growth rates, although to a lesser degree. These improved growth rates are a consequence of hybrid vigour. The combining ability of indigenous breeds must be studied carefully if heterosis traits in meat production are to be exploited.

Effects of sex and growth

Males grow faster than females from birth to 12 months of age and these differences essentially reflect differences in size at maturity, with males being heavier at maturity than females (Table 1). In certain areas of the Indian subcontinent, male kids intended for slaughter are castrated. In Muslim areas of Asia, the market demand favours intact male goats for slaughter (Devendra and Owen 1983). Recently, many researchers (Louca et al. 1977; Senger 1978; Chawla and Iqbal Nath 1980; Kumar et al. 1980; Devendra and Owen 1983) have studied the effect of castration on growth. Generally, castrates grow faster than intact males (Table 2). Senger (1978) observed that under identical conditions of housing, feeding, and management, castrates (open) grew better than intact males. These differences reflect differences in mature size of the breed.

The age at which castration should be done to get maximum returns is still open to speculation. Castration at 2 months was superior to castration at both 1 and 3 months (Table 2). Of the unilateral and bilateral methods used (Senger

Table 2. Effects of timing and method of castration on growth of goat breeds.

Breed	Time after birth	Method[a]	Weight range (kg)	Growth rate (g/day)	Source
Beetal					
Intact	4 days	-	10-15	44	Chawla and
Castrated	5 days	O	10-15	44	Iqbal Nath
	3 months	O	10-15	47	(1980)
	6 months	O	10-15	51	
Bengal					
Intact	-	-	10-15	41	Singh et al.
Castrated	2 months	E	10-15	44	(1985)
Jamunapari x Bengal					
Intact	-	-	10-15	50	
Castrated	2 months	E	10-15	64	
Barbari					
Intact	-	-	5-10	22	Sengar (1978)
Castrated	1 month	O	5-10	25	
	2 months	O	5-10	27	
	3 months	O	5-10	25	
Barbari					
Intact	-	-	15-20	25	Kumar et al.
Castrated	15 days	O	15-20	26	(1980)
		E	15-20	27	
	1 month	O	15-20	40	
		E	15-20	39	
	2 months	O	15-20	35	
		E	15-20	36	
	3 months	O	15-20	31	
		E	15-20	33	

[a]O, open; E, emasculator.

1978), the bilateral method was more effective; Sidhar et al. (1978) found that open castration at 1 and 2 months of age had a significant ($P < 0.05$) effect on live weight gain, whereas length, height, and paunch girth remained unaffected. They concluded that castration at 1 month of age was more economical in terms of improved body weight gain. The effect of castration at different intervals of age (5 days, 3 months, and 6 months) on live weight at 9 months in Beetal goats suggests that maximum growth was obtained with castration at 6 months followed by castration at 3 months (Table 2). Early castration (5 days) had no effect.

Kumar et al. (1980) observed no significant differences in weight gains and preslaughter weights in open or emasculator methods of castration at different age intervals, i.e., 15 days, 1 month, 2 months, and 3 months (Table 2). Among castrated animals, however, 1-month castrates gained significantly ($P < 0.05$) more weight (23.50 kg) than their intact counterparts (15.66 kg) slaughtered at 18 months.

Carcass yield

The dressing percentage (D%) has long been used to estimate the food value of meat and relates carcass weight to live weight. This parameter is rarely used as an indicator of carcass yield, unless it is quoted on an empty body weight basis (Devendra and Owen 1983) to eliminate the variation caused by gut contents; this can be as much as 29% of the live weight (Owen et al. 1977). Generally, a D% of 45–50% (live weight basis) for males is common and this increases with a concomitant increase in live weight in almost all goat breeds (Table 3). A higher plane of nutrition generally yields a higher D%; this was demonstrated by Gaili et al. (1972) with Sudan Desert goats and by Devendra (1966) with Katjang goats. To maximize the growth of kids between weaning (3 months) and slaughter

Table 3. Effect of live body weight on dressing percentage in goats.

Breed	Sex[b]	8–15 kg	15–20 kg	20–30 kg	30–40 kg	Source
Jamunapari	M	48.10	49.65	52.15	-	Pant et al.
	F	44.45	43.85	43.03	-	(1974)
Osmanabadi	M	44.41	44.73	45.20	-	Reddy and
		(50.30)	(51.40)	(52.10)	-	Raghavan
	F	41.37	43.10	42.40	-	(1984)
		(51.00)	(52.40)	(51.10)		
Katjang	M	-	44.21	51.39	-	Devendra and
			(50.61)	(58.32)		Owen (1983)
Angora	M	38.56	36.65	43.62	-	Ghaneker et al.
x local		(49.29)	(47.93)	(53.07)		(1973)
Sudan	M	34.5	-	-	-	Ibrahim and
Desert		(49.2)				Gali (1985)
Sirohi	M	44.3	44.5	50.6	52.1	Prasad (1985)
		(55.2)	(56.5)	(58.8)	(59.9)	
Beetal	M	44.5	45.7	49.6	50.3	Prasad (1985)
		(50.2)	(52.3)	(58.2)	(58.1)	
Jhakrana	M	42.6	46.7	49.6	-	Prasad (1985)
		(56.1)	(56.9)	(58.7)		
Kutchi	M	43.5	44.5	50.5	-	Prasad (1985)
		(54.4)	(55.8)	(58.3)		
Marwadi	M	45.74	50.18	49.71	-	Prasad (1985)
		(52.38)	(56.81)	(57.22)		

Note: Values in parentheses are dressing percentages based on empty body weight; all others are based on live weight.
[a]M, male (all males are entire); F, female.

(9 months), the weaner kids were subjected to two feeding regimes (8-h browsing and browsing + ad lib. concentrate supplementation) to assess the effect of D%. Concentrate supplementation in addition to browsing resulted in a 2–3% increase in D% in Sirohi and Beetal × Sirohi (Table 4), suggesting that heavier goats dressed higher than lighter goats by 2–4% on a higher plane of nutrition. Parthasarathy et al. (1984) observed an increase of 5% in D% when kids were supplemented with ad lib. concentrate in addition to browsing. Reddy and Raghavan (1984) observed that increasing the concentrate component of the ration from 30 to 70% increased the D% by about 2.5% and reduced the time taken to attain a slaughter weight of 24 kg by 1.5 months.

Effects of sex and castration

At a given live weight, males are generally heavier than females (Wilson 1958; Louca et al. 1977; Owen et al. 1978). Pant et al. (1974) observed that D% was lower in female Jamunapari goats than in males (Table 3). Likewise, in Osmanabadi goats, D% is always lower in females than in males (Reddy and Raghavan 1984). Pant et al. (1974) observed, however, that D% in Jamunapari goats was highest in females of 10–15 kg live weight and in males of 25–30 kg live weight.

Castration of male goats eliminates odours in the meat, rendering it more palatable (Devendra and Owen 1983). Castration has a range of effects on D%; the time of castration is important in this respect. Castration at 5 days (Chawla and Iqbal Nath 1980) and 15 days (Kumar et al. 1980) did not result in any significant improvement of D% (Table 5); however, castration at 7 days in Damascus goats produced carcasses with a slightly higher D% (56.4) than those of intact males (55.7%), whereas late castration (7.5 months) yielded a lower D% of 54.9% (Louca et al. 1977). Castration at 6 months in Barbari (Srivastava et al. 1968) and Alpine × Beetal goats (Chawla and Iqbal Nath 1980) improved D% by 0.8 and 1.5%, respectively (Table 5). In Alpine × Beetal, castration at 3 months improved D% by 2.2%.

Khumar et al. (1980) observed the effects of method (open or emasculator) and timing (15 days, 1 month, 2 months, or 3 months) of castration on D% under identical conditions of feeding, management, and slaughtering (18 months). The improvement as D% or a result of castration was significant ($P < 0.05$); the difference in improvement between emasculator and open methods was insignificant. Kids castrated at 1 month yielded higher carcass weights when compared with 15-day, 3-month, and 6-month castrates, irrespective of the method of castration.

Table 4. Effect of the plane of nutrition on dressing percentage (empty body weight) of intact, male goats.

Feeding regime	Breed	8–15 kg	15–20 kg	20–30 kg	30–40 kg
8-h browsing	Sirohi	55.5	56.0	-	-
	Beetal x Sirohi	-	56.1	56.9	-
Browsing + concentrate	Sirohi	-	57.4	58.1	59.9
	Beetal x Sirohi	-	57.3	57.9	59.6

Source: Bhatia (1985).

Carcass composition

Allometric growth equations relating the differential growth rates of lean meat, bone, and fat indicate that as the body weight increases, the rate of bone growth decreases, the growth rate of lean meat remains constant or increases slightly (Tulloh 1963), and the fat tissue has a greater differential growth rate. This was demonstrated in male Botswana castrates, where the growth coefficients of lean meat, bone, and fat were 1.1697, 0.7756, and 1.9947, respectively (Owen et al. 1978), indicating that goats appear to be relatively late in maturing, with fat tissue not reaching an appreciable proportion of body weight until a heavy live weight is achieved. Generally, the lean meat composition of goat carcasses is about 60% (Devendra and Owen 1963); values are as high as 66% in intact Malawi goats (Owen 1975) and 68% in intact Alpine goats (Fehr et al. 1976) and as low as 53.9% in male and female Philippine goats (Argañosa et al. 1977) have been reported.

The percent lean meat in the carcass has been found to be strongly related to transverse surface area of the longissimus dorsi muscle, usually cut between the 12th and 13th rib in sheep and goats (Devendra and Owen 1983). Singh and Senger (1970) found this to be true in male Barbari and Jamunapari goats. In goats of approximately 20 kg live weight, the area of longissimus dorsi varied from 4.12 cm^2 in New Zealand feral males and females (Kirton 1970) to 16.12 cm^2 in Philippine entire males and females (Argañosa et al. 1977). The longissimus muscle developed significantly with increases in live weight (Ghanekar et al. 1973). This is true for several indigenous goat breeds of the Indian subcontinent (Table 6).

It is generally accepted that goat meat is leaner than mutton (Devendra and Burns 1983) and that goats deposit less subcutaneous fat and more visceral fat

Table 5. Effect of timing and castration method on dressing percentage (D%) of goats.

Breed	Time after birth	Method[a]	Live weight (kg)	D%	Source
Alpine x Beetal					
Intact	-	-	19.38	50.00	Chawla and
Castrated	5 days	O	18.38	50.35	Iqbal Nath
Intact	-	-	18.00	48.50	(1980)
Castrated	3 months	O	18.33	50.68	
Intact	-	-	18.40	51.68	
Castrated	6 months	O	17.08	52.98	
Barbari					
Intact	-	-	21.05	49.81	Srivastava
Castrated	6 months	E	21.20	49.93	et al. (1968)
Barbari					
Intact	-	-	15.66	43.79	Kumar et al.
Castrated	15 days	O	18.00	49.86	(1980)
		E	18.70	50.86	
	1 month	O	23.50	51.26	
		E	23.60	51.26	
		E	23.60	51.90	
	2 months	O	21.60	50.80	
		E	21.50	50.70	
	3 months	O	20.30	49.21	
		E	20.45	48.13	

[a]O, open; E, emasculator.

Table 6. Area (cm^2) of eye muscle (longissimus dorsi) in various breeds of male goats at different live weights.

Breed	Live weight range (kg)			
	8-15	15-20	20-25	25-30
Sirohi	-	6.20	9.94	10.82
Beetal	-	7.25	7.35	11.20
Beetal x Sirohi	4.45	-	9.78	10.30
Jhakrana	-	-	7.65	9.88
Kutchi	-	6.20	7.30	8.43

Source: Prasad (1985).

(Ladipo 1973; Owen et al. 1977; Owen et al. 1978). The amount of abdominal and renal fat was significantly ($P < 0.05$) higher in castrates than in intact goats (Chawla and Iqbal Nath 1980; Kumar et al. 1980). Fat levels are highly variable and depend on weight, breed, plane of nutrition, and sex (Owen et al. 1978). These aspects have been excellently reviewed by Devendra and Owen (1983).

Lean meat to bone ratios have been used to compare breeds and carcass meat yields. Generally, this ratio increases as empty body weight increases. Lean meat to bone ratios ranged from 2.7:1 for dairy goats (Ladipo 1973) to 3.8:1 for Jamunapari and 4.9:1 for Barbari goats (Srivastava et al. 1968).

In view of the demand for lean meat in India and the price differential for different carcass joints, attempts have been made to evaluate the percent bone content in the carcasses of almost all breeds of goats. The percentage of bone is higher in crossbreeds than in indigenous purebreds slaughtered at 12 months. The differences in bone content between indigenous breeds and crossbreeds could be due to the faster development of bone than of muscle, which is a comparatively late-developing tissue (Gaili et al. 1972).

Muscle composition

The chemical composition of the muscle depends on the degree of fattening and the cut used for analysis. The variation in intra-muscular fat content with regard to anatomical location, influence of castration, sex, and breed has been thoroughly reviewed by Devendra and Owen (1983). The longissimus dorsi muscle had a high level of intramuscular fat (Ladipo 1973; Owen et al. 1978). Because the quantity of lean meat in the carcass has been found to be strongly related to the area of eye muscle (Devendra and Owen 1983), this muscle has been used as an index to assess chemical composition. The deposition of intramuscular fat was lower (0.94 to 1.5%) in indigenous breeds of the Indian subcontinent (Mishra 1981; Keshava Rao et al. 1984) when compared with Alpine, Toggenburg, Nubian, and Saanen goats (2.01%) over a range of live weights (Ladipo 1973). In Alpine × Beetal castrates, slightly higher levels of fat (1.8%) were observed than in intacts (1.5%) (Chawla and Iqbal Nath 1980); the moisture, protein, and mineral contents were similar in intact and castrated animals.

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Discussion

This session reviewed the present knowledge on goat meat production and outlined strategies for its improvement. A common theme was the characterization of indigenous goat resources from the viewpoint of assessing the relative potential of different breeds under intensified management and feeding systems. The efficiency of utilization of available fibrous feedstuffs including nonconventional feeds and the consequent economics of production were considered crucial for the envisaged improved production systems to be successful. It was pointed out that there is a lack of physical and economic data on which improved production could be based. Therefore, research on producer herds and at experiment stations is needed to generate such data. The technical possibilities for improving production should be clearly defined from the farmer's point of view, and concentrated efforts should be made in introducing the new technology to the farmers.

The first paper of this session was a comprehensive review of the work carried out on breeding aspects with special reference to India. The proposed strategy for genetic improvement was based on increased production and use of selected males. Selection for meat production should be based on 6-month weight; this characteristic has the highest heritability (h^2) and has high genetic correlation with yearling and adult body weights. Nucleus herds organized by the cooperatives or the farmers' herds could be utilized for producing selected bucks.

Following the presentation of this paper, discussion centred on the advisability of crossbreeding. It was pointed out that the utilization of heterosis need not be an important consideration for the present as there are larger opportunities in utilizing additive genetic variance. The major advantage of crossbreeding is in milk production. Indian experience has shown that crossing Saanen and Alpine depresses twinning. Improved, dual-purpose breeds like Anglo-Nubian may have a role in crossbreeding.

The next paper highlighted the areas in which research is needed to predict goat performance within controlled feeding and management systems. The crucial area in this regard is the efficiency of feed conversion under different feeding regimes.

The discussion of this paper covered the use of feeding standards, optimum planes of nutrition, and the feeding of high-quality forages, of which several examples were given. It was pointed out that there is no increase in the efficiency or quality of production when goats are fed in excess of the recommended standards. It was emphasized that feeding trial reports should analyze input and output price relationships. The strategies suggested to expand the feed base and to increase the utilization of available feed resources involved more efficient utilization of crop residues and other neglected feedstuffs, use of various nitrogen sources, urea–molasses blocks, protein supplementation, and use of proteinaceous forages. Silage making was also discussed. This was considered a complex problem and only justified if there is considerable surplus feed available and if methods of silage making are sound.

The third paper in this session dealt with the reproductive factors that affect goat meat production. Possible methods of improving age at first mating, kidding interval, kidding, and early kid mortality were proposed. The importance of considering the seasonality of reproduction in different breeds was emphasized. Indian experience in reducing prenatal kid loss suggests that the kidding rate could be substantially increased by controlling uterine infection. It was also pointed out that early kid mortality was reduced when colostrum was fed within 10 min of birth.

The discussion following the presentation of this paper highlighted the roles of improved nutrition and strategic feeding in improving reproductive output. It was considered possible through proper management to reduce the kidding interval to about 240 days.

The fourth paper in this session covered goat diseases and their control. Several topics were discussed following the presentation. Anthrax has now been controlled in India; however, it could be endemic in some of the drier parts of the country. Intensive vaccination was provided in these regions. Caution was necessary when feeding hybrid sorghums, immature green maize, and millet fodder to goats. Hybrid sorghums may cause hydrocyanic acid (HCN) poisoning. Feeding mixed forage such as with napier grass was one way of overcoming the problem. Immature green maize and millet fodder may be responsible for bloat and, therefore, feeding mixed dry feeds was practical.

Much of the discussion centred on increasing the supply of veterinary services to the rural farmers, emphasizing that the existing veterinary infrastructure was insufficient. Even in villages close to veterinary headquarters, where veterinaries are available, facilities are not supplied to the farmers. Delivery systems to extend health services to a village or a flock, taking note of the socioeconomic status of the farmer, must be considered.

In India, successful extension services through the development of cooperatives have been successful. In Pakistan, village aid programs and cooperative systems have not been successful. It was pointed out that the farmer must be made to realize his own benefits and advantages. Bold steps may have to be taken to create market interest. If there is market interest, cooperatives will survive.

The final paper of this first session covered the influence of sex on goat meat production. Males grow faster than females and, in general, large breeds and crossbreeds of large and small goats produce heavier kids with good growth characteristics. Castrates grow faster than entire goats, irrespective of the method of castration. The dressing percentage of females is lower than that of males and a high plane of nutrition improves both weight gain and dressing percentage. It was also observed that crossbred goats have a higher bone content at 12 months than do the smaller, indigenous goat breeds. Increases in body weight are reflected in increases in the loin eye area.

During the discussion of this paper, it was pointed out that early castration does not cause any increase in muscle or bone but does cause a slight increase in visceral fat. There is no profound difference in the growth of castrates; however, castration is a practical method of preventing indiscriminate mating among goats. It was pointed out that, in many countries of Asia, castrates are unacceptable to the consumer; chemical sterilization may be an alternative to castration. The delegates generally agreed that consumer preferences should be given some priority.

Session II

Qualitative Factors

The nutritional value of goat meat

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Abstract: *Information on the nutritional value of goat meat is one of extreme paucity. Although the meat is widely consumed and is an important source of animal protein in most developing countries, surprisingly few studies have been undertaken on the nutritional properties of the meat. Three types of goat meat are consumed: meat from kids, meat from young goats, and meat from old goats. The per caput supplies of goat meat over the last 20 years are decreasing consistently in all regions of the developing world. A widening gap between production and consumption has resulted in increased prices. The chemical composition of goat meat is as follows: moisture, 74.2–76.0%; protein, 20.6–22.3%; fat, 0.6–2.6%; ash, 1.1%. Goat meat appears to contain more arginine, leucine, and isoleucine than mutton and is adequate in all the essential amino acids. Goat meat also has a relatively lower fat content because the tissue is more concentrated in the viscera. The fatty acid composition of subcutaneous, kidney, and intermuscular fat depots appears to be similar to that of sheep, except that goats tended to have more oleic acid (C18:1) in their fat depots. The implication of this feature is an increased value of the purchased product (lean meat). The Ca content of goat meat is inferior to that of beef. Goat meat has higher thiamine and riboflavin contents in the liver, but niacin was lower than that in beef. Management factors affect the proximate composition of the meat and the eating quality, especially tenderness, flavour, and juiciness. Castration tends to increase the fat content of the meat. Toughness of the meat is related to age at marketing, collagen content and solubility, size of muscle fibres, and muscle contraction. Limited data suggest that the inclusion of up to 70% goat meat in fresh and smoked sausages significantly increased the flavour and acceptability.*

Résumé: *L'information sur la valeur nutritive de la viande caprine est d'une extrême rareté. Même si la consommation de cette viande, source importante de protéines animales dans la plupart des pays en développement, est répandue, on s'étonne du petit nombre d'études sur ses propriétés nutritives. On consomme trois sortes de viande de chèvre : la viande de chevreau, la viande de jeune chèvre et la viande de chèvre âgée. Au cours des 20 dernières années, la production per capita de cette viande n'a cessé de diminuer dans toutes les régions du monde en développement. L'augmentation de l'écart entre la production et la consommation a entraîné une hausse des prix. La composition chimique de la viande caprine est la suivante : humidité : 74,2–76 %, protéines : 20,6–22,3 %, gras : 0,6–2,6 %, cendres : 1,1 %. Cette viande renferme davantage d'arginine, de leucine, d'isoleucine que la viande ovine; tous les acides aminés essentiels y sont en quantité suffisante. De plus, sa teneur en gras est relativement plus basse en raison de la concentration des tissus graisseux dans les vicères. Par ailleurs, la teneur en acides gras des dépôts graisseux sous-cutanés, rénaux et intermusculaires de la viande caprine s'apparente à celle du mouton; toutefois, les réserves graisseuses de la chèvre renferment en général plus d'acide oléïque (C18 pour 1), d'où plus grande valeur du produit (la viande maigre) à l'achat. La teneur en Ca de la viande caprine est inférieure à celle de la viande bovine. Le foie de chèvre est plus riche en thiamine et en riboflavine, mais plus pauvre en niacine que celui du boeuf. La qualité des soins influe sur la composition approximative de cette viande et sa palatabilité, en particulier sa tendreté, son goût et sa texture juteuse. En général, la castration en augmente la teneur en gras. Quant à sa dureté, elle est fonction de l'âge de l'animal au moment de sa commercialisation, de sa teneur en collagènes et de sa solubilité, de la taille de ses fibres musculaires et de la contraction des muscles à l'abattage. Malgré leur nombre limité, les données disponibles indiquent que la présence de 70 % de viande caprine dans la saucisse fraîche ou fumée en améliore beaucoup le goût et l'acceptabilité.*

Resumen: *La información sobre el valor nutricional de la carne de cabra es extremadamente escasa. Aun cuando este tipo de carne se consume ampliamente y es una importante fuente de proteína animal en la mayor parte de los países en desarrollo, es sorprendente el hecho de que se hayan*

realizado pocos estudios sobre las propiedades nutricionales de la misma. Son tres los tipos de carne de cabra que se consumen: carne de cabritos, de cabras jóvenes y de cabras adultas. Los suministros per capita de carne de cabra durante los últimos 20 años están disminuyendo consistentemente en todas las regiones del mundo en desarrollo. Un abismo que se amplía entre la producción y el consumo ha originado un aumento de los precios. La composición química de la carne de cabra es como sigue: humedad, 74,2–76,0%; proteína, 20,6–22,3%; grasas, 0,6–2,6%; ceniza, 1,1%. La carne de cabra parece contener mAs arginina, leucina e isoleucina que la de carnero y tiene una coposición adecuada de aminoácido relativamente bajo de grasa porque el tejido está más concentrado en las vísceras. La composición ácido-grasa de los depósitos subcutáneos, riñones y de grasa intermuscular parece ser similar a la de la oveja, excepto por el hecho de que las cabras tienden a tener un mayor contenido de ácido oléico (C18:1) en sus depósitos de grasa. La implicación de esta característica es un aumento en el valor del producto que se compra (carne magra). El contenido de Ca de la carne de cabra es inferior al de la carne de res. La carne de cabra tiene contenidos más altos de tiamina y riboflavina en el hígado, pero el contenido de niacina es menor que en el de la res. Los factores de explotación afectan la composición futura de la carne y la calidad al comerse, especialmente la blandura, sabor y jugosidad. La castración tiende a incrementar el contenido de grasa de la carne. La dureza de la carne está relacionada con la edad en el momento de la comercialización, el contenido de colágeno y la solubilidad, el tamaño de las fibras musculares y la contracción muscular. Información limitada sugiere que al incluir hasta un 70% de carne de cabra en salchichas frescas y ahumadas aumentó significativamente su sabor y aceptabilidad.

In many parts of the tropics and especially in those countries with high goat populations, goat meat is highly relished and sought after. It is the meat of choice and demand often exceeds supply, such that the prices of both the meat and the live animals are often the highest on the farm. This pattern exists in many developing countries (Devendra and Owen 1983; Devendra 1987). There has also been a trend toward consumer substitution of goat meat with imported mutton, often of inferior quality.

Three types of meat are consumed in the developing countries (Devendra 1981):

- Meat from kids (8–12 weeks);
- Meat from young goats (1–2 years); and
- Meat from old goats (2–6 years).

Kid meat is a speciality common mainly in Latin America, the Caribbean, parts of Africa, and Southeast Asia. Kids are slaughtered at weights of 6–8 kg. Young goat is the most common type consumed and is the main topic of discussion in this paper. In terms of quality, the best young goat meat is produced at a live weight range of 11–25 kg, depending on breed and environment. Owen (1975), for example, in a study of goats slaughtered at 4–8, 9–14, and 15–24 months, reported that mature goats were superior to younger goats in meat production. Likewise, yearling (12–20 months) Angora goats produced chops and roasts that were juicier and more tender ($P < 0.05$) than those from 3- to 5-month-old kids (Smith et al. 1978). Goat meat is consumed in three forms: fresh, chilled, or frozen; fresh meat is by far the most popular.

There are several factors closely associated with the extent and pattern of goat meat consumption: regional differences, systems and intensity of production, ownership, affluence, ethnology, and religion. Developing countries account for 93% of world goat meat production and consume the bulk of this production. Developing countries produce only 7% of the world's goat meat and much of this meat is consumed by the immigrant populations of North America, Europe, Australia, and New Zealand. Although goat meat is widely consumed, knowledge of its nutritive value is extremely limited. The sparse knowledge base is a reflection of the degree of appreciation of goat meat in qualitative terms and, despite its

quantitative importance, the extent to which it has been taken for granted. This paper summarizes the present knowledge of the nutritional characteristics of goat meat.

Patterns of consumption

The percentage of indigenous production of carcass meat accounted for by goat meat is generally small (3.9–9.4%) and decreasing, being highest in Africa and Asia (Table 1), with 88% of the world goat population. In relation to decreasing production and without exception, there is also a decreasing trend in per caput production; the highest per caput goat supply is in Africa, followed by Asia (Table 1).

Demiruren (1982) projected that in 14 selected countries the demand for goat meat and milk in 1990 will require a 2.8% increase in production above the present per caput consumption. Given the present static growth rates of these products and the decreasing per caput supply (Table 1), however, it is unlikely that this 2.8% increase will be met. The Technical Advisory Committee report (TAC 1985) also indicates that the gap between production and consumption is increasing faster for goat meat than for other food commodities.

There are four major developments concerning the trends in Table 1:

- Inadequate goat meat supplies have resulted in increased prices for the meat and the live goats, including the breeding animals;
- The high price of goat meat has encouraged unscrupulous substitution by imported mutton from poor-quality sheep;
- The demand for goat meat has encouraged increased slaughter of breeding animals with a consequent erosion of the base population in quantitative and qualitative terms; and
- The reduced availability of breeding animals has also resulted in some countries to shift from goat to sheep production.

In many developing countries, goats and sheep are traditionally owned by small farmers, peasants, and landless agricultural labourers, to whom the ownership of these animals had significant nutritional, socioeconomic advantages. Their

Table 1. Percentage of the indigenous production of carcass meat accounted for by goat and per caput goat meat in 1961-1965, 1974, and 1984 throughout the world.

	% of indigenous production[a]			Per caput goat meat supply[b] (kg/year)		
Region	1961-65	1974	1984	1961-65	1974	1984
Africa	9.9	8.2	9.4	1.20	0.91	1.13
North America	0.1	0.1	0.1	0.06	0.06	0.08
South America	1.0	0.5	0.6	0.43	0.32	0.24
Asia	5.0	3.9	3.9	0.47	0.40	0.44
Oceania	0.1	0.1	0.1	0.12	0.10	0.11

Source: FAO (1974, 1984).
[a]Percentage of beef and veal, mutton and lamb, goat, buffalo, pig, and poultry meat.
[b]Includes offals.

Table 2. Proportion (%) of households reporting the purchase of goat meat and imported mutton by income and race in Peninsular Malaysia.

Monthly household income (MYR)[a]	Malay		Chinese		Indian	
	Goat meat	Imported mutton	Goat meat	Imported mutton	Goat meat	Imported mutton
<100	2	38	0	10	0	100
100-199	5	49	3	11	6	96
200-299	4	51	2	17	27	64
300-499	8	58	5	18	10	90
500	7	68	13	27	58	75

Source: Devendra (1983).
[a]In February 1988, 2.4 Malaysian ringgits (MYR) = 1 United States dollar (USD).

small size, in particular, is of special significance and is related to biological, managerial, and economic factors (Devendra and Burns 1983).

In terms of the contribution to human nutrition, an important, often inadequately appreciated contribution of goats is their supply of animal proteins to the rural community. With particular reference to vulnerable groups, pregnant and nursing mothers, and young, the rearing of goats supplies a small but significant supply of high biological value animal protein in the form of meat and milk plus essential minerals and fat-borne vitamins. For little investment, goats provide an easy source of meat and milk to rural people who cannot afford to buy these products or are unable to survive rearing cattle and buffaloes. The magnitude of this contribution is not known, but it is likely much more significant than realized.

There is evidence that the demand for goat meat increases as income increases. At high income levels, people are willing to pay as much as two to three times the cost of imported mutton on account of demand being greater than supply. In Malaysia, for example, within all races, the demand for goat meat increased with increasing income (Table 2). Thus, it is implicit that if the demand for more animal protein is to be met and the quality of life is to be improved, to maximize production in Malaysia, all feed-production avenues must be fully exploited. The contribution of goats is important if this objective is to be achieved.

Nutritional characteristics

The moisture content of goat meat in India, Malaysia, and the Philippines varies from 74.2 to 76.0%; protein, 20.6–22.3%; fat, 0.6–2.6% (Table 3). The ash content is fairly constant around 1.1% and the Ca and P content are variable (Table 3). In general, the compositions of goat meat and mutton are comparable with respect to moisture, protein, and ash contents (Thulasi and Ayyaluswami 1983). The fat content was surprisingly lower in mutton despite the higher subcutaneous content of fat in sheep relative to goat meat. The nutritive value of goat meat reported in this study is comparable to the data of Rai (1969) for goat meat in Uttar Pradesh, India.

Protein

The protein component and especially the amino acid profile is the most important component of goat meat. Protein is especially important in the developing

Table 3. Chemical composition of goat meat in some countries.

Component	India[a]	Malaysia	Philippines[b]
Moisture (%)	74.2	74.0	76.0
Protein (g/100 g)	21.4	20.6	22.3
Fat (g/100 g)	2.6	2.2	0.6
Total carbohydrates (g/100 g)	-	-	-
Fibre (g/100 g)	-	-	-
Ash (g/100 g)	1.1	1.0	1.1
Ca (mg/100 g)	12	11	6
P (mg/100 g)	193	154	150
Fe (mg/100 g)	-	2.1	0.4

[a]Source: Gopalan et al. (1971).
[b]Source: Abdon et al. (1980).

Table 4. Amino acid composition (g/16 g N) of meat samples in India.

Amino acid	Goat meat	Mutton	Beef	Pork	Ideal protein
Arginine	7.4	6.8	6.8	7.1	6.6
Histidine	2.1	2.8	3.0	3.4	2.4
Lysine	7.5	7.9	8.1	8.7	7.5
Tryptophan	1.5	1.4	1.4	1.3	1.6
Phenylalanine	3.5	3.3	3.4	3.6	5.8
Methionine	2.7	3.1	2.9	3.4	2.8
Threonine	4.8	4.6	4.5	5.2	5.0
Leucine	8.4	7.6	7.5	8.2	10.0
Isoleucine	5.1	4.6	4.5	5.4	6.6
Valine	5.4	5.5	4.9	6.0	7.0
Tyrosine	3.1	3.0	3.4	3.5	0.0
Cystine	1.2	1.3	1.1	1.1	0.0

Source: Srinivasan and Moorjani (1974).

world, where there is a great need for dietary proteins of animal origin to provide a concentrated source of readily assimilable amino acids. The consequences of an inadequate supply of animal protein include such deficiency diseases as marasmus and kwashiorkor. The elimination of malnutrition because of deficient food quality and undernutrition arising from deficient food quantity is essential for the betterment of human life.

Goat meat contains more arginine, leucine, and isoleucine than mutton (Table 4). The pattern of the remaining amino acids is similar to that of mutton. Pork contains more histidine, lysine, methionine, threonine, and valine than beef, goat meat, and mutton (Table 4). A comparison with the essential amino acid pattern of the ideal protein in Table 4 showed that goat meat is approximately similar with respect to arginine, lysine, tryptophan, methionine, and threonine. Goat meat contains 87.5, 60.4, 82.0, and 81.8% of the essential amino acids, histidine, phenylalanine, leucine, isoleucine, and valine, respectively, compared with the ideal reference protein. Goat meat is adequate with respect to all the essential amino acids (Srinivasan and Moorjani 1974). The limiting amino acids are the sulphur-containing amino acids followed by valine and isoleucine. A comparison of the results with the FAO (1965) reference protein pattern indicated all the meats contained more than adequate amounts of the essential amino acids. The average biological values (BV) of goat meat, beef, and buffalo meat were 60.4, 68.6, and

59.5, respectively, based on feeding trials with rats fed a 10% level of protein (Mitra and Mitra 1945).

Fat

An important distinctive feature of goat meat, especially compared with mutton, is its fat distribution. A characteristic feature in goats is that they tend to deposit most of their fat internally (mesenteries, renal tract, and alimentary tract). This feature, together with the reduced deposition of subcutaneous fat, makes goat meat leaner than mutton or beef. This is seen, for example, in the results of measurements of the thickness of subcutaneous fat at a point 20 mm from the medical plane along the caudal edge of the 13th rib. This measurement on Boer goats at slaughter weights of 23, 32, and 41 kg gave values of 1.2, 1.8, and 3.4 mm; on four sheep breeds (Pedi, Merino, Dorper and S A Mutton Merino), values of 2.3–9.6, 3.4–9.8, 3.5–8.8, and 4.8–10.6, respectively, were obtained (Bruwer 1984). Therefore, in terms of cost per unit of lean meat and in nutritional terms, goat meat is preferable over mutton, beef, and pork. With feral goats in New Zealand, Kirton (1970) reported a complete absence of subcutaneous fat in the loin.

During growth, there is limited change in the composition of intramuscular fat. Perirenal and mesenteric fats have a high proportion of saturated stearic acid (C18:0) because of the process of biohydrogenation of unsaturated fats especially oleic (C18:1), linoleic (C18:2), and linolenic (C18:3) acids. The low content of subcutaneous fat in goat meat suggests that the content of polyunsaturated fatty acids (PUFA), which are beneficial to human nutrition, is also likely to be low. Ladipo (1974) reported that the caul and intermuscular fats from goats have a higher lipid concentration than subcutaneous fat and that intramuscular lipids consisted mostly of cholesterol and phospholipids. Duncan et al. (1976) showed that, as in sheep, depot glycerides in goat contain an abnormally high proportion of odd-numbered n-fatty acid and methyl-branched fatty acids. More recently, fatty acid contents of lipids from the triceps brachii, biceps femoris, and obliquus internus abdominis in Korean native goat meat have been reported by Ha et al. (1986) to be as follows, palmitic (C16:0), 24.5–25.6%; oleic, 55.2–59.6%; linoleic, 4.0–8.1%. Unsaturated fatty acids predominated (68.5–72.3%).

In the Sudan, Gaili and Ali (1985a) reported from comparative studies that goats tended to deposit more fat in the omentum and mesentery than sheep. By comparison, sheep deposited more fat in the carcass. In a continuation of this study, the fatty acid composition of fat depots was compared in Sudan Desert goats and sheep by Gaili and Ali (1985b). No significant species differences existed in the proportions of fatty acid and palmitic, stearic, and oleic acids accounted for more than 90% of the total fatty acids. Goats tend to have a slightly higher proportion of oleic acid and less linoleic acid than sheep in all fat depots (Table 5).

The relatively poor fat covering on the carcasses of goats implies that subcutaneous fat cannot be used as a predictor of yield for goats as it is for lamb and mutton carcasses. An alternative criterion must be used to classify and grade goat carcasses.

Minerals and vitamins

The mineral and vitamin contents of goat meat have been inadequately studied and only scattered information exists. In the Philippines, some useful data

Table 5. Proportions of fatty acids in the subcutaneous, intermuscular, and kidney fat depots of Sudan Desert goats and sheep.

	Subcutaneous			Intermuscular			Kidney		
Fatty acid	Goats	Sheep	SE[a]	Goats	Sheep	SE[a]	Goats	Sheep	SE[a]
Pentadecanoic	8.3	7.7	0.5	10.7	10.9	1.8	9.9	9.6	1.2
Palmitic	32.2	32.2	1.0	32.1	33.2	0.9	32.0	32.9	0.7
Stearic	28.9	30.1	1.9	28.0	28.9	0.9	27.5	28.1	0.8
Oleic	28.7	28.2	0.8	28.2	27.8	0.7	28.1	27.7	0.4
Linoleic	1.9	1.8	0.2	2.0	1.9	0.3	1.8	1.7	0.2

Source: Gaili and Ali (1985b).
[a]Standard error of the difference between the two means.

Table 6. Mineral and vitamin contents (mg/100 g) of goat meat and beef in the Philippines.

	Calcium		Phosphorous		Thiamine		Riboflavin		Niacin	
Component	Goat meat	Beef	Goat meat	Beef	Goat meat	Beef	Goat meat	Beef	Goat meat	Beef
Lean meat	12	96	127	194	0.10	0.10	0.56	0.20	3.6	6.4
Liver	17	26	172	310	0.51	0.16	2.79	0.96	10.6	5.4
Lungs	15	40	142	144	0.10	0.14	1.16	0.18	2.9	3.0
Kidney	15	44	189	184	0.65	0.24	5.70	2.56	4.0	5.2
Large intestines	-	13	-	28	0.04	0.04	0.14	0.08	0.5	0.2
Small intestines	20	20	886	173	0.04	0.07	0.19	0.32	0.7	1.5
Heart	8	18	154	181	0.61	0.33	3.82	0.59	5.4	4.8
Stomach	48	156	84	63	0.06	-	0.36	0.14	0.7	1.4

Source: Abdon et al. (1980).

have been published on the mineral and vitamin contents of different parts of lean meat as well as that of different organs of goat meat compared with beef. Concerning Ca, with the exception of the small intestines, goat meat is inferior to beef (Table 6). The small intestines of goats, however, have a P content that is approximately five times that of beef. The P content in kidneys was comparable in both goat meat and beef (Table 6). Goat meat has a higher thiamine content than beef in the liver, kidney, and heart. The riboflavin content was also higher in lean goat meat and in goat liver, kidney, heart, and stomach. The niacin content of beef and beef kidney was higher than in lean goat meat and goat kidney; however, goat liver and heart have higher niacin contents than beef liver and heart (Table 6).

Management factors and nutritional value

In India, Kansal et al. (1982) studied the effects of different methods of castration and vasectomy on the proximate composition and eating quality (palatability) of Alpine × Beetal bucks between 2 and 6 months of age (Table 7). The moisture content of the meat of intact goats was 76.4%. This decreased significantly ($P < 0.01$) in animals whose testes were removed at the age of 6 months. No significant differences were found in vasectomization at 2, 4, or 6 months, castration by burdizzo at 2 or 4 months, or testes removal at 2 months

Table 7. Effects of different methods of castration on moisture, protein, and fat contents of muscles and in vitro digestibility of meat protein of Alpine x Beetal bucks in India.

Method	Age[a]	Moisture (%)	Fat (%)	Protein (%)	Pepsin digestion (%)	Trypsin digestion (%)
Burdizzo	2	75.7±0.4	2.6±0.3**	19.6±0.3**	26.2±1.2**	46.3±3.0**
	4	76.7±0.2	1.3±0.1	20.6±0.4	28.4±2.8**	49.9±5.2*
Testes removal	2	76.2±0.8	1.6±0.1	20.7±0.6	22.5±4.3	37.1±4.2
	6	73.2±0.8**	2.5±0.2**	21.8±0.3	21.3±3.3	37.1±3.7
Vasectomy	2	75.5±0.7	2.4±0.3	20.6±0.5	19.5±2.4	33.2±4.8
	4	75.4±0.8	1.9±0.1**	20.0±0.6*	23.3±2.3*	41.8±3.5
	6	75.9±0.2	2.5±0.2**	20.1±0.4*	16.5±2.7	37.1±3.7
Intact control		76.4±0.7	1.3±0.2	21.7±0.6	16.7±1.7	34.2±1.6

Note: Values are the means of 14 determinations. *, $P < 0.05$; **, $P < 0.01$.
Source: Kansal et al. (1982).
[a]Age in months.

(Table 7). These results differ from those of Baillargeon et al. (1971), who observed that the mutton from intact lambs contained more water than that from lambs castrated by burdizzo.

Differences in protein content were statistically significant only in the cases of goats vasectomized at 4 or 6 months ($P < 0.05$) and in those castrated by burdizzo at 2 months ($P < 0.01$) (Table 7). Similarly, a slightly lower level of protein than in intact animals has been reported in sheep castrated by testes removal or by stopping blood supply to the testes (Baillargeon et al. 1971).

The intramuscular fat in intact goats was less than that in goats vasectomized, castrated by burdizzo, or with testes removed. The increase in intramuscular fat was statistically significant ($P < 0.01$) in goats vasectomized at 2, 4, or 6 months, castrated by burdizzo at 2 months, or with testes removed at 6 months (Table 7). In Botswana, Owen et al. (1978) found that castrated goats had a higher proportion of both dissectable and total fat in the carcass.

The eating quality or palatability of the meat is associated with tenderness, juiciness, flavour, and aroma. Kansal et al. (1982) undertook a sensory evaluation of Alpine × Beetal meat using a 1–9 scoring scale and reported that there were no differences in tenderness, flavour, or juiciness between intact goats and those castrated by burdizzo, with testes removed, or vasectomized. Similar results were obtained for mutton by Baillargeon et al. (1971). Smith et al. (1974), however, reported that goat meat was less tender than lamb, beef, and pork but compared favourably with beef and pork in juiciness. Kansal et al. (1982) also found that goats castrated by burdizzo at 2 or 4 months had significantly more pepsin- and trypsin-digestible proteins than intact goats (Table 7).

In South Africa, the palatability of goat meat is considered inferior to that of lamb and mutton and has been linked to the marketing of mature animals (van Tonder 1980). The collagen content was implicated and a comparison of muscles in the Boer goat compared with four sheep breeds (Pedi, Merino, Dorper, and S A Mutton Merino) revealed that the former had an inherently higher collagen content with low solubility (Heinze et al. 1986). Heinze et al. (1986) concluded

Table 8. Tenderness and cooking loss in the meat of Katjang goats in Malaysia.

Muscle	Tenderness[a]	Cooking loss(%)
Rectus femuris		
Male	37.6±3.5	4.3±0.9
Female	33.0±6.3	3.6±1.0
Longissimus dorsi		
Male	32.3±3.4	3.7±0.3
Female	27.8±2.4	3.8±0.3

Note: Four males and four females were used, each about 3.4 years of age.
Source: Devendra (1983).
[a]Warner-Bratzler shearing force value.

that an evaluation of collagen alone was insufficient for an assessment of tenderness or toughness and that other factors, especially the type of matrix formed by the collagen, the muscle fibres, and the state of muscle contraction must also be evaluated.

Tenderness is best evaluated by the Warner–Bratzler method, which measures shear force. Limited work has been done in Malaysia on this aspect (Devendra 1983). It was evident that the meat from does was more tender than that from intact Katjang bucks of the same age (Table 8). Cooking losses of the rectus femuris and longissimus dorsi muscles were also higher (3.8–4.3%) in entire bucks than in the does (Table 8).

In the Philippines, attempts have been made to include goat meat up to a level of 70% in sausages. Consumer judges rated 50% lean goat meat in both fresh and smoked sausages, which replaced 50% pork, as having the best flavour and acceptability among the four sausage preparations (50% goat meat:50% pork fat, 60% goat meat:40% pork fat, 50% goat:30% pork fat, and 70% pork:30% pork fat). It was concluded that with the proper pretreatment, goat meat can be used as the main ingredient in sausage recipes (Argañosa 1985).

Conclusions

The nutritional characteristics of goat meat have been inadequately studied. The information that is available is based on a few, scattered studies that, together, do not presently provide an understanding of the nutritional properties of goat meat. The limited evidence suggests that differences are likely to exist in proximate composition of the meat, type and quality of the fat, and mineral and vitamin contents. Other important differences in nutritional value are related to tenderness, flavour, juiciness, and palatability (eating quality) of the meat; these factors are associated with collagen content and solubility. The relatively poor fat covering in goat meat merits special consideration in the assessment of yield and carcass quality. Given these circumstances and considering the wide consumption of goat meat in the developing world, there is an urgent need for concerted research on the nutritional properties of goat meat.

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Characteristics of goat meat including carcass quality and methods of slaughter

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Abstract: *Goat meat is widely eaten throughout the world and is used more than other farmed animals in warm climates. The dressed carcass commonly comprises 36–54% of live weight with many factors, which are discussed, contributing to this variation. While mean carcass weights commonly range from 10 to 14 kg, large breeds produce carcasses up to 50 kg. Carcass and meat quality are dependent on the postmortem carcass-inspection system (or lack of same) and the carcass composition and palatability characteristics relative to market requirements. A goat carcass normally contains more muscle (56–68%) and bone than a sheep carcass of similar age (46–60% muscle), the latter species containing more fat. Much less research has been undertaken on the characteristics of the goat carcass than that of the sheep.*

Résumé: *La consommation de la viande caprine est répandue partout dans le monde et son utilisation dans les pays chauds l'emporte sur celle de tous les autres animaux de la ferme. Habituellement, le poids d'une carcasse habillée représente de 36 à 54 % du poids vif, nombreux étant les facteurs, étudiés ici, qui contribuent à cet écart. Même si le poids moyen des carcasses est habituellement de 10 à 14 kg, celui des races de grande taille peut atteindre les 50 kg. La qualité des carcasses et de la viande dépend du système d'inspection des carcasses après l'abattage (ou de son absence), ainsi que des exigences du marché quant à leur composition et leurs caractéristiques de palatabilité. D'habitude, une carcasse de chèvre présente plus de muscles (56–68 %) et d'os que celle du mouton d'âge semblable (46–60 % de muscles), cette dernière est cependant plus grasse. Enfin, la recherche s'est beaucoup moins intéressée aux caractéristiques des carcasses de chèvre qu'à celles des carcasses de mouton.*

Resumen: *La carne de cabra se consume en grandes cantidades a través del mundo y se utiliza más que ninguna otra carne de animales de granja en climas cálidos. La canal recubierta comprende comúnmente del 36 al 54% del peso vivo, contribuyendo a esta variación muchos factores que se discuten en este trabajo. Mientras que los pesos de canales medianas comúnmente se sitúan entre 10 y 14 kg, las clases mayores producen canales hasta de 50 kg. La calidad de la canal y de la carne dependen del sistema de inspección de la canal (o la ausencia del mismo) que se pone en prática después del sacrificio del animal y la composición de la canal y las características de palatabilidad relativas a los requisitos del mercado. Una canal de cabra normalmente tiene más músculo (56–68%) y huesos que el de una oveja de edad similar (46–60% de músculo), conteniendo estas últimas especies un mayor volumen de grasa. Se ha hecho mucha menos investigación sobre las características de la canal de la cabra que sobre las de las ovejas.*

Goats are important as a source of meat and other products (fibre, milk, skins, etc.) (Harvey and Rigg 1964; French 1970: Devendra 1979; Jackson 1981: Devendra and Burns 1983; Devendra and Owen 1983; Peters and Deichert 1984; Ahmad 1984; Anjaneyulu et al. 1985; Gisèle 1987). The goat is of major importance as a source of animal products in warm climates and receives more attention than the other animals that are emphasized in temperate climates.

Goat meat, or chevon, is widely eaten throughout the world, with the greatest production being in Asia and Africa; it accounts for about one-third of the meat production of India, Pakistan, and Bangladesh, about only 3.5% of the world meat production (1979 statistics; Devendra and Owen 1983). Goat meat is widely eaten in Africa. In many other regions, it is regarded with suspicion, prejudice, and as inferior to mutton (French 1970). The lack of availability of goat meat and mistrust of meats not normally eaten places goat meat near the bottom of meat preferences in Western societies where beef, pork, chicken, and lamb are the preferred meats; lamb is the least preferred of these meats and is relatively unknown in many countries. Deer meat (venison) is sold on a small luxury market. Goat meat is a preferred meat in countries where it is a normally available product, e.g., Sudan, many parts of Africa, the Middle East, Malaysia, and Fiji (Devendra and Burns 1983).

In tropical and subtropical countries, goats have the advantage that they can survive and grow on vegetation too fibrous for other ruminants. Their small carcasses (10–14 kg; Devendra and Owen 1983) enable them to be slaughtered and the meat distributed and eaten in countries without organized meat-distribution systems before the meat spoils. The meat from a larger animal, such as a cattle beast, poses much greater distribution problems unless refrigerated storage is available.

In Western societies, where over- rather than under-nutrition is accepted as a health problem, the lower fat content of deer and goat carcasses in contrast to the higher fat content of beef, sheep, and pig carcasses may encourage the acceptance of these relatively unknown meats. Finally, meat from goats (and sheep) may be acceptable to those who, for religious or other reasons, will not eat pork (e.g., Moslems or Jews) or beef (Hindus).

Slaughter methods

Little experience on slaughtering goats exists in New Zealand. If the products of the goat or other animals are intended for international trade, there is a growing body of opinion requiring the animals to be rendered insensible to pain before their throats are cut. This is now normally achieved by stunning the animals before slaughter, especially where the animals are processed through an established slaughterhouse. Stunning may be achieved by a blow to the head or by shooting the animal. Such methods are not recommended as the former is unreliable and the latter can be dangerous to the operators. In countries with well-established meat industries and distribution systems, the preferred (humane) stunning methods for sheep and goats are electrical stunning and the captive bolt pistol method. The latter method should not be used if the brain is to be saved for consumption. Where there is a religious requirement that the animal be alive when the throat is cut (Moslem and Jewish slaughter), electrical head stunning has been certified as suitable by religious authorities as it has been satisfactorily demonstrated that after stunning by this method, provided the throat is not cut to allow bleeding, the animals will recover consciousness and behave normally. If the religious requirement is not present, head-back electrical stunning is preferred as this causes spinal discharge removing the leg movement (kicking) reflexes and increasing safety for the slaughterer during the initial stages of dressing.

Details on electrical stunning and the preferred method for dressing sheep are given in Barton-Gade et al. (1988). Similar methods are applicable to goats. Preferably, the dressing and evisceration procedures take place with the body off

the floor for hygienic reasons. For sheep, the hindquarter-to-head and head-to-hindquarter dressing systems can be readily adapted for a solo, on-farm butchery or in small abattoir systems. The same applies to goats; however, where mechanical methods are used to assist with skin removal, the head-to-hindquarter method has been judged easiest.

For hindquarter-to-head dressing, the hind legs should be held by mechanical fingers or from a gambrel through the hocks while the skin is being removed. For the head-to-hindquarter method, the forelegs must be held by mechanical fingers until the skin is pulled over the hind legs. This latter method produces a hygienic hindquarter untouched by hand or knife when a mechanical method is used to complete the skin removal. After skin removal by either method, the carcass is usually suspended from a gambrel through the hock of the hind legs to permit evisceration. Where offal is being saved for human consumption, it should be placed in a clean tray for separation and inspection. Where chilling and freezing are used as methods of preserving goat meat, attention must be paid to the prevention of postmortem cold and thaw shortening, which can cause the meat to become tough (Savic 1974; Savell et al. 1977).

The edible portion

In most countries where goat meat is eaten, many body parts apart from the dressed carcass are consumed. These commonly include the liver, kidneys, heart, and tongue, and may also include the brain, cheek, intestines, lungs, spleen, blood, fat, and even skin, although the skin is more commonly saved for making leather. In Malaysia, for example, 61% of the goat may be edible and 82% may be saleable (Devendra and Burns 1983). In Botswana, 70–75% of the body of goats is eaten; in Malawi, up to 76% of the goat is consumed (Owen and Norman 1977). These values include bone and the review by Devendra and Owen (1983) reports 48–75% of the body of goats to be edible in different locations and 56–96% of the body as commercially valuable.

In this paper, the term "carcass" is synonymous with "dressed carcass," which is usually defined as the headless, footless, skinned, eviscerated body. Feet, head, perirenal fat, kidneys, and skin may or may not be removed depending on the country and the market. Obviously, the presence or absence of some of these components will have an effect on dressing percentage; the carcass must be clearly defined before comparisons can be made between different sets of reported results.

Dressing percentage

Dressing percentage is usually roughly defined as the carcass expressed as a proportion of live weight. As just mentioned, however, the carcass can vary according to the components retained or removed before weighing. If the head, feet, and dehaired skin are retained, the dressing percentage will be higher. In addition, in some countries, a shrunk carcass is used as the basis for recording carcass weight and for financial transactions. The shrunk carcass weight is usually estimated by removing a standard deduction from the actual (hot) carcass weight at slaughter to allow for the weight loss (mainly moisture) that occurs as the carcass is cooling. The shrunk carcass weight is an estimate of what the carcass will weigh when it reaches the wholesaler or retailer (if they are part of the meat-distribution sys-

tem). Where shrunk carcass weight is the normal weight reported, dressing percentages will be lower than where hot carcass weight is reported. For the remainder of this discussion the carcass used in dressing percentage values is the headless, footless, skinned, eviscerated body.

Another important factor affecting dressing percentage is whether the animals are weighed straight off feed or if they have had time to expel some gut contents before weighing. The type of feed can also influence how much gut fill is present in the animals at the time of weighing. Where such factors cannot be specified, some variation in dressing percentage must be expected apart from difference because of animal age, size, breed, fatness, and the other factors known to influence dressing percentage (see Table 8 of McGregor (1984) and Colomer-Rocher (1987)).

Although kids receive most of their nutrition from milk, they are essentially monogastric and will have a higher dressing percentage because of a low level of gut fill. Dressing percentages of 52–62% have been reported for young kids (see Devendra and Owen 1983). As the kids start eating fibrous material, they develop a large rumen and the gut fill will increase, markedly lowering dressing percentage. As the goat approaches maturity and if some fat is accumulated in the carcass, the dressing percentages will again increase slightly in comparison with a younger ruminating goat.

Table 4 of Devendra and Owen (1983) summarizes dressing percentages from 11 published experiments undertaken before 1983 with animals classified by breed and sex. Mean values range from 36.9% (carcass weight/live weight) for 15–20 kg Criollo goats to 53.1% for 20–30 kg Angora or Angora × local goats. While most experiments showed a tendency for increased dressing percentage with increasing live weight, this did not apply in a few studies.

Results from some uncastrated and partially castrated 6-month-old Barbari kids reported dressing percentages of 35.6% (entires) to 36.4% (partial castrates) (Mogha et al. 1984). Recently reported values in the range of 39–50% are common (e.g., Vidyadaran et al. 1984; Butler-Hogg and Mowlem 1985; Kanaujia et al. 1985; Singh et al. 1985; Verma et al. 1986), with Bose and Basu (1984) reporting dressing percentages of slightly greater than 51% for some 1- and 2.5-year-old Beetal goats.

Given that gut contents alone of up to 26% of goat live weight have been reported (Owen et al. 1983), some of the lower dressing percentages that have been reported are not surprising. Gaili et al. (1972) noted that after removal of animals from feed (but with access to water) 24 h before slaughter, goats off a normal fibrous diet averaged (over three ages) 18.0% stomach contents whereas those off a fattening diet averaged 8.8% stomach contents. The dressing percentage of unfattened goats averaged 41.2%; fattened animals, 51.4%. These data and those of Owen et al. (1983) highlight the major contribution that variation in the contents of the digestive tract can make to the dressing percentages of goats and other ruminants.

A breakdown of the major components that may affect dressing percentage is given in Table 1. Similar data may also be found in Wilson (1960) and Owen et al. (1983), with components presented as percentages of empty body weight. Apart from the digestive tract contents, the other main body components listed in Table 1 that differ between groups and may contribute to differences in dressing percentage include skin weight and head weight. The latter (head weight) is likely to be influenced by the size of the horns. However, despite the 7.2% greater contribu-

tion to body weight by the skin and head in the feral goats of McGregor compared with the Saanen goats (Table 1), the feral goats' dressing percentage was only one unit lower. This shows that the increased contribution of these two components was offset by the smaller contributions from other components. In well-fed goats, differences in internal fat may also contribute to dressing percentage differences.

Characteristics of goat carcasses and meat

The quality of the carcass and meat from goats and other species is mainly judged in terms of meat hygiene (freedom from disease and dirt), carcass/meat composition, and palatability. Different markets have different requirements for carcass/meat composition (some like more and some like less fat), where a choice is available and palatability requirements can also depend on the customs and background of the people (Martin 1984). Europeans are suspicious of goat meat because it is something they have never or do not normally eat; in Nigeria, however, goat meat may be preferred because of its "chewability" (Obanu 1975). Thus, we must accept that the judgement of what factors constitute meat quality is highly subjective.

Table 1. Components (approx. %) of live weight in goats[a].

	McGregor (1982)		Kirton (1970)		Owen and Norman (1977) (Botswana)		Babiker et al. (1985) (Sudan Desert)[b]	
Component	Saanen wether	Feral wether	Feral male	Feral female	Kid	Adult	Entire	Castrate
Carcass	46.4	45.3	44.8	42.2	43.3	48.3	45.8	47.6
Blood	-	-	-	-	3.7	2.8	-	-
Skin	6.4	11.1	11.6	9.7	7.3	6.6	7.3	7.0
Head	6.6	9.1	9.0	7.6	6.3	5.3	8.4	8.7
Liver	1.9	2.1	2.3	2.5	1.6	1.6	2.2	2.1
Heart	0.8	-	-	-	0.4	0.2	0.5	0.5
Spleen	0.2	0.2	0.2	0.2	-	-	0.3	0.2
Kidneys (two)	0.6	0.3	0.4	0.5	-	-	0.4	0.5
Lungs and trachea	1.3	1.7	1.8	1.8	1.3	1.2	2.4	2.4
Omental fat	3.3	0.3	0.4	1.0	0.5	1.8	-	-
Stomach (empty)	3.2	3.5	3.7	4.4	-	-	-	-
Intestines + contents	-	-	7.9	9.5	-	-	-	-
Stomach contents	-	-	8.8	7.5	-	-	-	-
Digestive tract	-	-	-	-	11.4[c]	11.5[c]	9.5	10.2
Tract contents	-	-	-	-	16.1	13.7	-	-
Other weight loss[d]	-	-	-	-	-	-	-	-

[a]The live weight on which most percentages were based was calculated from hot carcass weight and the dressing-out percentage of live weight. Castrate males were used.

[b]From the Babiker et al. (1985) data, values are calculated on an empty body weight (and not live weight) basis.

[c]Including spleen and pancreas.

[d]Items not recorded in the table include the feet and the weight loss (feces and urine) between recording live weight and slaughter.

Carcass weight

Average goat carcass weights from different regions of the world have been reported to range from 10 kg (Africa) to 14 kg (Near East) with an overall global mean of 12 kg (Devendra and Owen 1983). Gisèle (1987) reported a similar range of values. Goat carcasses tend to be smaller than those of similar-aged sheep. In a table reporting the mature size of goats from a variety of sources, McGregor (1984) lists the Improved Boer as having the greatest mature weight of up to 110 kg live, with Saanens approaching 100 kg. These values imply carcass weights approaching 50 kg. Colomer-Rocher (1987) reported adult male Saanen goats with hot carcass weights ranging from 44.0 to 51.9 kg and adult females ranging from 21.0 to 32.0. Although illustrating the variation available, the majority of goat breeds are lighter than these two extremes. Carcass weight is obviously influenced by age, breed, sex (males are larger than females), nutrition, and many other factors.

Carcass linear measurements

External linear measurements may be taken for descriptive purposes and measurements on the cut surfaces of a sectioned carcass may be used as indicators of fat and muscle contents. The latter may be related to consumer preferences. All measurements are normally positively correlated with carcass size.

Commonly taken external carcass measurement are usually similar to those defined by Palsson (1939) for sheep and often include some or all of carcass length, F (distance from end of leg to crutch), T (length of tibia tarsus), carcass depth/thorax depth, and the metacarpal (cannon bone) may be skinned and measured (e.g., Srivastava et al. 1968; Kirton 1970; Owen 1975; Fehr et al. 1976; Owen and Norman 1977; Khan and Sahni 1979; Owen et al. 1983). Most measurements are indicators of carcass and leg length, with goat carcasses being longer and leggier than similar weight sheep carcasses (Owen and Norman 1977) (Fig. 1).

Measurements A (maximum eye muscle (longissimus dorsi) width), B (depth), and C (fat thickness over maximum depth) as described by Palsson (1939) and the area of the cross section of the eye muscle cut between the 12th and 13th ribs or behind the last rib have been taken on goat carcasses. The only report on subcutaneous fat thickness C described a complete absence of fat (Kirton 1970), but, undoubtedly, some goat carcasses have some fat cover. Srivastava et al. (1968), Kirton (1970), and Khan and Sahni (1979) have reported measurements A and B, the Jamunapari kids of Khan and Sahni (1979) having the largest eye muscles at a comparable weight.

Several authors have reported on eye muscle area on the same cross section where measurements A and B are performed. Devendra and Owen (1983) summarized the results of five trials with areas reported for 20-kg live goats and not including the results of Owen (1975) from male Malawi goats. Values range from 4 for New Zealand feral and unfattened Sudan Desert goats to 9 for Mexican Criollo goats. Fattening the desert goats increased the area to 6.5 mm^2 at the same live weight. A value of 16 cm^2 was reported for Philippine goats, a remarkably large value, if correct.

Carcass composition

Summaries of the lean (muscle), dissectible fat, and bone contents of goat carcasses mainly from African, Mexican, and French sources have been reported by

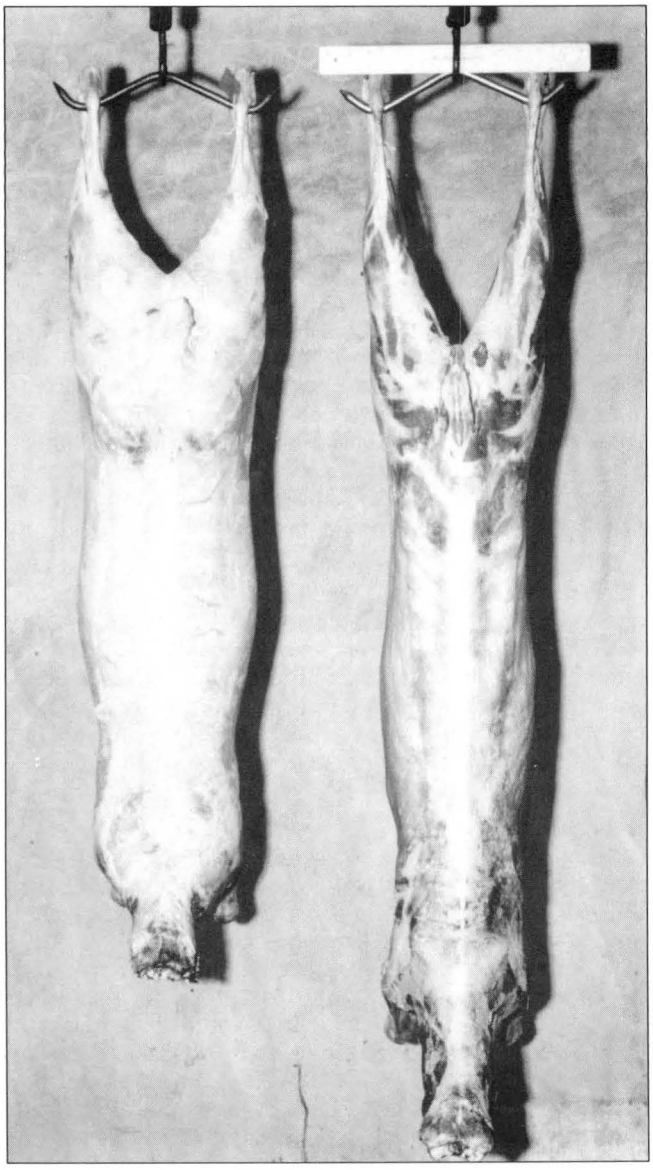

Fig. 1. Typical carcasses of sheep (left) and goat (right).

Devendra and Owen (1983), McGregor (1984), and Gisèle (1987), the latter also including the Philippines, Malaysia, and Guadeloupe. Anjaneyulu et al. (1985) summarized information from some Indian breeds. In addition, results have been published on male Sudan Desert goat carcasses (Gaili 1976; Ibrahim and Gaili 1982) and on the loins of male and castrate goats of the same type (Babiker et al. 1985). Results on the chemical composition of whole goat carcasses (Kirton 1970; McGregor 1982) and of the edible meat (fat plus muscle; Gaili et al. 1972) have also been reported.

The reported mean values show the normal range of carcass muscle content covers from 56% (Owen et al. 1983) to at least 68% (Fehr et al. 1976). The lower values come from young, immature goats, from older, fatter goats, or from goats of a harsh environment. The muscle content of goat carcasses are higher than those normally found for sheep, which are commonly reported to have 48–60% muscle in their carcasses (Owen et al. 1978; Kirton et al. 1985). Mean carcass fat (by dissection) in goat carcasses ranges from under 4% in young goats (Owen et al. 1983) to 18% in mature goats (Anjaneyulu et al. 1985) with Colomer-Rocher (personal communication) recording over 20% carcass fat (subcutaneous and intermuscular; over 27% if kidney fat is included in the carcass) in large Saanen females. McGregor (1984) reported 32% carcass fat in grain-fed Angora × feral does. In comparison, the dissectible fat in lamb carcasses commonly ranges from 20 to 35% and values of up to 60% chemical fat have been observed in the carcasses of mature female sheep (Kirton et al. 1959). Owen (1978) reported female sheep were fatter than female goats on a weight-corrected basis and Gaili et al. (1972) reported that the meat (fat and muscle) of unfattened and fattened Sudan Desert goats ranged from age-group means of 5.5 to 30% ether extract and for similar age groups of unfattened and fattened Sudan Desert sheep from 9 to 45%. The carcass weights of these animals were not reported.

The reported bone content (treatment means) of goat carcasses ranges from 43.6% (young unfattened desert goats; Gaili et al. 1972) to 15.9% (yearling Malawi male goats; Owen 1975). Several factors may account for the different reported values. Different measurement techniques will affect bone contents: some authors may clean the bones more thoroughly than others. The level of nutrition can also influence the bone content. For example, Gaili et al. (1972) reported 15–19% more carcass bone in unfattened goats compared with fattened goats of the same breed and sex; their report did not allow for a possible carcass weight effect.

In most trials, older goats have heavier carcasses and a lower proportional bone content compared with younger goats (Owen 1975; Gaili 1976; Fehr et al. 1976; Owen et al. 1983; Colomer-Rocher, personal communication). The report of Fehr et al. (1976), covering a doubling in carcass weight of kids but with the least difference in age of the reported experiments, recorded a low (2%) reduction in bone with increasing weight, suggesting that the age/maturity component of decreasing bone may be more important than the weight component. Castrated male Criollo goats had a recorded reduction in the proportion of carcass bone of 4.6% as they increased in carcass weight from 3.6 to 9.5 kg; for this experiment the change of age was not recorded (Owen et al. 1983). Owen et al. (1978) reported no change in percentage carcass bone as young Botswana castrate goats changed from milk teeth to full mouth for animals of the same carcass weight. As the proportion of fat in the goat carcass increases (confounded with an increase in age and weight), the proportion of bone decreases (Gaili et al. 1972; Owen 1975; Colomer-Rocher personal communication).

Sheep and cattle research has shown a small but significant genetic component to differences between groups of animals in the proportion of bone (and muscle and fat) in the carcass when compared on a weight basis. Genetic differences can, therefore, be expected to account for some of the reported differences in carcass bone from various experiments. There is an absence of direct breed comparative studies on the carcass composition from different goat breeds and crosses. Using minimal numbers of young male Boer goats, Owen et al. (1978)

detected a lower bone content only when compared with similar-weight indigenous entires.

Sex differences may contribute to some of the variation in bone content reported. Research on sheep has shown that entire males have slightly higher bone contents than castrates (Butterfield et al. 1984) and increasingly higher bone contents than females with increasing carcass weight (Fourie et al. 1970). The results of Owen et al. (1978), Guney (1984), Babiker et al. (1985), and Misra et al. (1986) provide no clear evidence for sex differences in the bone content of goats.

Whereas Vidyadaran et al. (1984) reported a muscle/bone ratio of 4.07:1 for 2- to 2.5-year-old Kambing Katjang does, Owen (1975) reported muscle/bone ratios ranging from 3.14:1 for 4- to 8-month-old indigenous Malawi males to 4.18:1 for 15- to 24-month-old animals. For young Criollo Mexican goats, this ratio ranged from 1.92:1 for 3.6-kg kid carcasses to 2.68:1 for 9.5-kg carcasses (age of animals unknown). Owen et al. (1978) gave muscle/bone ratios of 2.59:1 for indigenous castrate Botswana goats, 2.39:1 for indigenous males, 3.16:1 for entire Boer goats, 2.93:1 for indigenous female goats, and 2.87 for indigenous sheep. The ratio for 4- to 6-month-old, male Sudan Desert goats was 2.0:1 (Ibrahim and Gaili 1982). Earlier results start to show a pattern when the effects of age and nutrition on the muscle/bone ratio are calculated from the data of Gaili et al. (1972) assuming that most of the nonbony tissue is muscle, an assumption that will cause the true ratio to be overestimated. Unfattened young goats had an average muscle/bone ratio of 1.29:1; unfattened mature goats, 1.75:1. When fattened, the young goat ratio increased to 2.66:1 and the mature goat ratio increased to 3.73:1. These and some earlier results illustrate that the muscle/bone ratio increases as goats mature and are likely to be higher in well-fed than in poorly fed animals.

Carcass cuts

The proportion of carcass cuts that may be taken from the sides of indigenous castrate Botswana goats and sheep as well as from a limited number of young entire male indigenous and Boer goats and young female sheep has been reported by Owen and Norman (1977). The main difference in the proportion of cuts (neck, shoulder, thorax, loin and flap, leg) removed at the same anatomical point from left sides of the castrates included the larger shoulders and legs of the goats and larger loins and flap (fat cuts) in the sheep. The goat cuts make up about 99% of the side weight; the sheep cuts, about 94% (the unaccounted component of the sheep being kidney and channel fat). Male Boer goats had a higher proportion of neck than the indigenous castrate goats or female sheep, the sheep having a markedly lower proportion of shoulder than any goat classes. The female sheep had larger loins and flap (2%) than the female goats, which, in turn, had larger loins (2%) than the entire males and castrates. Percentages for the same cuts have also been reported for Criollo goats by Owen et al. (1983). Other reports available on the proportion of the different cuts in the goat carcass include Kirton (1970), Fehr (1976), Babiker et al. (1985), and Butler-Hogg (1985). The studies of Owen et al. (1978) and Gaili (1976) provide information on the composition of the cuts.

Muscles and muscle fibres

Owen et al. (1983) reported on the longissimus dorsi and biceps femoris muscles as a proportion of total muscle tissue. The longissimus reduced from 10% in young male castrate goats (3.6-kg carcass) to 8.5% in those goats with 9.5-kg carcasses. The biceps reduced from 4.1 to 3.3% in the same carcasses. For sheep,

expected values (entire males and females) have been reported as 9–10% of total muscle for the longissimus and 4–5% of total muscle for the biceps (Jury et al. 1977).

Owen et al. (1978) reported on the intramuscular fat content of the biceps femoris, psoas major, and the thoracic and lumbar parts of the longissimus dorsi muscles and from the remaining muscle of sheep and goats. There were no major differences between the fat contents of the sheep and goat muscles, with most levels being under 3.5%, apart from the remaining muscle, which just exceeded 5% for mature goats.

Desert goats had 15–40% thicker muscle fibres than sheep and there were differences in fibre diameter between the three different muscles measured by Gaili et al. (1972). Fattened goats and sheep had greater muscle fibre diameters than unfattened animals. No clear evidence was given for a relationship between fibre diameter and palatability.

Prediction of goat carcass quality

Carcass quality is a combination of satisfactory hygiene, the appropriate carcass composition for the particular market, and satisfactory palatability characteristics. In Western societies, emphasis may be placed on tenderness and flavour; in African societies, emphasis may be placed on chewability.

For meat traded internationally, veterinary or veterinarian-supervised meat inspection is compulsory. For meat intended for local consumption, such inspection is desirable and compulsory in many countries. The objective is to have a system that certifies that the animals from which the products have been taken are free of disease and that the meat is free from other matter (such as dirt and feces) that may transmit disease to the human population. That is, the inspection comprises a public health measure and certifies one aspect of carcass/meat quality. Systems required for imported meat may also be intended to prevent the introduction of animal diseases not present in the importing country. In some developed countries the inspection procedures have been carried to extremes and include matters that appear unrelated to human health. Inspection requirements seem to be a method of providing work for veterinarians and appear to be used as non-tariff barriers to prevent the entry of the product from some countries into some marketplaces. Some meat inspection is desirable but the process can be carried to extremes.

The carcass composition of most species slaughtered at a licenced premises is usually specified through a carcass classification/grading system. Because fat is present at a lower level in goat carcasses than in other species and because little goat meat is eaten in high-income societies where classification systems have been established for pig, sheep, and cattle carcasses, there has been less effort to develop a goat carcass classification system. If one was to be introduced, a goat carcass classification system would be expected to include animal age, carcass size, breed (if large and small breeds were to be processed in the same slaughter plant), fat cover, and possibly sex (if it was considered desirable to separate entire males from castrates). All goat carcasses have a leggy conformation when compared with pigs, cattle, and most sheep. This is partly a reflection of their low fat cover. For this reason it is unlikely that conformation would be a useful addition to a goat carcass classification system. Classification according to age may assist in

the prediction of carcass quality. The specification of a postmortem carcass treatment may also have a role to play in assisting the prediction of carcass quality.

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Qualitative aspects of goat meat including processing, storage, and organoleptic factors

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Abstract: *Quality traits are divided into composition of the meat to indicate nutritive value, physical characteristics for showcase acceptance, organoleptic traits for acceptability, and processing characteristics to relate response to normal processing treatments. Normal lean goat meat (chevon) has a brick red colour and chalk-white fat. With an increase in maturity, the colour of the meat darkens and the fat remains white; any variation from white fat lowers the showcase acceptance of the meat. Goat meat is acceptable as cooked intact meat, as part of prepared recipes, and as a processed product. There are indications that it can be used in any recipe or processed product instead of beef or carabeef. The emulsion capacity of goat meat is similar to lamb and higher than beef and carabeef. The stability of the emulsions produced is similar to emulsions made from beef, carabeef, horse meat, and lamb. The salt-soluble protein content of goat meat is similar to that of beef and lamb and higher than that of carabeef.*

Résumé: *Les traits de qualité se répartissent suivant la composition de la viande qui en indique la valeur nutritive, l'aspect qu'elle doit avoir pour sa présentation, les facteurs organoleptiques qui en déterminent l'acceptabilité, et les particularités de la transformation qui la rend aussi acceptable que les autres viandes transformées. La viande caprine maigre présente habituellement une couleur rouge brique tandis que son gras a la blancheur de la craie. Avec la maturation, la viande prend une teinte plus foncée tandis que le gras, lui, reste blanc, toute modification de la teinte blanche du gras influant sur la qualité de la présentation. La viande caprine peut être cuite telle quelle, entrer dans la composition de mets ou être utilisée comme produit transformé. On croit qu'elle peut remplacer le boeuf ou le carabao dans les mets ou les produits de transformation. Le pouvoir émulsionnant de la viande caprine ressemble à celui de la viande de mouton et est supérieur à celui de la viande de boeuf ou de carabao. La stabilité de ses émulsions ressemble à celle de la viande de boeuf, de carabao, de cheval ou de mouton. La teneur de la viande caprine en protéines salino-solubles est analogue à celle des viandes bovines et ovines et supérieure à celle de la viande de carabao.*

Resumen: *Los rasgos de calidad se dividen en composición de la carne para indicar el valor nutritivo, características físicas para hacer que el producto tenga aceptación una vez que esté expuesto al público, rasgos organolépticos de aceptabilidad, y características de procesamiento para hacer que haya una relación entre los resultados obtenidos en la calidad de la carne y los tratamientos normales de procesamiento. La carne magra normal de caprinos tiene un color rojo ladrillo y la grasa color yeso. Cuando el animal avanza en edad, el color de la carne obscurece y el de la grasa permanece bianco; cualquier variación en el color de la grasa blanca disminuye la aceptación que tiene la carne cuando se expone en la vidriera. La carne de cabra tiene aceptación como carne entera cocinada, como ingrediente de recetas preparadas y como producto procesado. Hay indicaciones de que se puede utilizar en cualquier receta oproducto procesado en substitución de la carne de res o de carabao. La capacidad de emulsión de la carne de cabra es similar a la del cordero y más alta que la de res y la de carabao. La estabilidad de las emulsiones producidas es similar a las que se obtienen de la carne de res, carabao, caballo y cordero. El contenido de proteína soluble en sal de la carne de caprinos es similar al de la carne de res y de cordero y más alto que el de la de carabao.*

Meat quality refers to a combination of traits that provide for an edible product that is attractive, appetizing, nutritious, and palatable after cooking. The ideal meat quality level combines the capacity to retain a high nutritive value in the cooked form with that to excel in satisfying numerous functional roles in the fabrication and processing of acceptable products. In addition to nutrition, these functional roles include water binding, emulsification, viscosity improvement, gel formation, foamability, adhesion, dispersion, fiber and film formation, stabilization, fat binding, flavour development and tenderness, and texture and juiciness of the cooked product (Briskley and Kauffman 1978).

The assessment of meat quality involves the evaluation of specific parameters that are affected by species, manner of utilization, and several other factors. Although some parameters are species specific, the method of evaluating these parameters is usually common for all species. Several authors view quality differently and classify the various parameters in different ways. In this paper, the parameters are divided into four categories: composition of the meat to indicate its nutritive value, physical characteristics for showcase acceptance, organoleptic traits for acceptability, and processing characteristics to relate response to normal processing treatments. Only the last three categories are discussed in this paper, the nutritional value of goat meat is discussed by Devendra (this volume).

Physical characteristics

The physical characteristics of goat meat (chevon) indicating quality have been identified. Quality in lamb refers to the factors that influence consumer acceptability and product palatability. The factors generally evaluated include the colours of the lean meat and fat, the firmness of the lean meat and the fat, flank streaking, feathering, and maturity. When ribbed carcasses are appraised, marbling, texture, colour in the rib eye, and maturity are the most important quality criteria (NLMB 1977).

Goat meat lean is brick red (Esguerra 1972) with chalk-white fat (Ibarra 1983). The colour of the muscle is mainly due to myoglobin and its derivatives; however, the species effect on colour is substantial. In addition to the quantity of the pigment, the type and chemical nature of the myoglobin influence muscle colour. The colour of the fresh meat is largely determined by the relative proportion and distribution of the purple reduced myoglobin, red oxymyoglobin, and brown metmyoglobin (Watts et al. 1966). The suggested method of measuring total pigment is based on the reflectivity of the meat samples at 525 m at the isobestic point of myoglobin, oxymyoglobin, and metmyoglobin (Stewart et al. 1965).

Colour is greatly influenced by the gross morphology of the muscle. At a high pH, the muscle has a closed structure and, hence, appears dark. Denaturation of sarcoplasm and myofibrillar proteins causes a severe loss in water-binding properties of the proteins, causing the fibers to open up; hence, the muscle appears pale (Briskley and Kauffman 1978). The ideal colour of goat meat has not been identified. In lamb, however, which is almost the same as goat meat, the desirable colour is bright pink. With increased maturity, the colour of the lean meat darkens. The colour of the fat should remain white; any variations from white hinders consumer acceptance.

Kumar et al. (1983) found that, considering the quality attributes of aroma, flavour, juiciness, and tenderness, 1- and 2-month castrates have the highest

quality meat followed by entires, 15-day castrates, and 3-month castrates. Entires had the coarsest muscles. Kumar et al. (1983) also observed no significant differences in pH or the contents of myoglobin, moisture, ash, protein, and fat.

Studies on the showcase acceptability of goat meat are rare and the traits affecting showcase acceptability have not been identified. In lamb, the characteristics of meat evaluated for showcase acceptance include firmness of lean meat and fat, flank streaking, feathering, and maturity. These traits are also believed to influence the cooking characteristics of the meat. Under Philippine conditions, however, these traits have not been given much importance. Prevailing recipes are mostly those that are easily modified, i.e., the characteristics looked for and missing in the meat can easily be added during the cooking process.

Organoleptic qualities

Sensory traits of intact meat

In a survey conducted by Kawabata et al. (1980), 48% of the panelists liked goat meat, 21% neither liked nor disliked it, and 31% disliked it; about 95% of the same panelists wanted beef. The acceptability of goat meat was about the same as for mutton or lamb. Smith et al. (1974) compared the palatability of goat meat with lamb, beef, pork, and horse meat. Goat meat had lower flavour, overall satisfaction, and tenderness ratings than all the other meats but had similar juiciness to beef, pork, and horse meat. According to this study, goat meat is less desirable than lamb, beef, and pork and about equal to horse meat.

Hircinoic acid contributes significantly to the flavour of goat meat (Wong 1975). Samples were found to have high levels of hircinoic and 4-methyl-nanoic acids in the fat. These two acids are regarded as the compounds responsible for the common flavour noted in cooked mutton and goat meat.

Devendra and Owen (1983) mentioned that the organoleptic quality of goat meat is affected by a range of preharvest factors such as breed, age, sex, and nutrition and by a number of postharvest factors. Pike et al. (1973) found that loin chops from 6- to 10-month-old goats were less tender and less flavourful than those from 14- to 20-month-old goats; however, overall satisfaction decreased with age. Devendra (1981) found that female Katjang goat meat was more tender but had higher cooking losses than males of the same age. Likewise, the meat from the females was juicier and more desirable than the meat from the males. Smith et al. (1974) demonstrated that as maturity of goat meat increased, flavour increased in intensity and juiciness, and tenderness and overall satisfaction decreased. Increased marbling and streaking on flanks or in overall fat deposition were not associated with increased juiciness, tenderness, or overall satisfaction. Savell et al. (1977) found that the tenderness of longissimus dorsi muscle of beef, lamb, and goats was improved by electrical stimulation but found no change in the flavour of the lamb and goat carcasses.

Sensory traits of goat meat in recipes

Utilization of goat meat is as variable as any other type of meat. The acceptability of any goat meat preparation is highly affected by the region and the eating habits of the community. The recipes indicated in this paper are popular and highly accepted recipes in the Philippines. Filipino dishes may be divided into

four groups: dry recipes represented by hamburger, sauced recipes represented by "caldereta," soupy recipes represented by "nilaga" and "sinigang," and meat flavoured recipes represented by spaghetti.

Hamburger

Argañosa and Bandian (1979) found that the colour and general acceptability scores of hamburger with goat meat were essentially the same as for beef and were higher than for carabeef (Table 1). A slight off-flavour was detected in beef and goat hamburgers. Flavour, saltiness, and juiciness scores were not significantly different among the hamburger types. Similar results were found by Padda et al. (1985) in goat meat patties.

Nilaga and sinigang

Nilaga and sinigang are similar: "nilaga" has no sour flavour and "sinigang" is a sour soup. In both recipes, the meat is tenderized by boiling it in water. Salt, black pepper, and selected green vegetables are then added. Argañosa and Bandian (1979) found no remarkable differences among beef, goat meat, and carabeef nilaga and sinigang (Table 1); they concluded that goat meat is as good as carabeef or beef for nilaga.

Spaghetti

Higher general acceptability and tenderness scores were found by Argañosa and Bandian (1979) for spaghetti containing goat meat than for spaghetti containing beef or carabeef (Table 1). There were no significant differences in the colour, flavour, off-flavour, saltiness, or juiciness of the spaghetti made with the three meats. Spaghetti is a dry, starch-based recipe that uses ground meat.

Caldereta

Caldereta represents the stew-type recipes of the Philippines. Reyataza (1978) found no significant differences in the flavour, off-flavour, desirability, or overall acceptance of caldereta prepared from goat meat, carabeef, or beef (Table 2). The mean flavour scores of beef and goat meat were almost identical, indicating that goat meat could substitute for beef in stew-type food preparations.

Table 1. Mean taste panel scores of hamburger, "nilaga," and spaghetti containing goat meat, beef, and carabeef.

Trait[b]	Hamburger[a]			"Nilaga"[a]			Spaghetti[a]		
	A	B	C	A	B	C	A	B	C
Colour	7.21a	6.83ab	6.33b	6.96a	7.54b	7.04a	7.93	7.86	7.21
Flavour	6.88	6.62	6.29	6.33b	7.50a	6.21b	7.47	7.12	7.06
Off-flavour	1.42b	1.50b	2.38a	2.88a	1.25b	2.42a	1.04	1.18	1.32
Saltiness	5.02	5.14	5.00	5.46	5.54	5.08	4.66	4.62	4.72
Tenderness	6.42	6.50	6.29	7.46	7.29	7.13	7.31a	6.94ab	6.78b
Juiciness	6.25	6.17	6.12	7.38	7.42	7.33	7.44	7.16	7.28
General acceptability	7.29a	6.96ab	6.67b	6.63b	7.67a	6.94b	7.67a	7.34b	7.38b

Note: Values in the same row and of the same food type followed by the same letter(s) are not significantly different.

Source: Argañosa and Bandian (1979).

[a]A, 100% goat meat (lean:fat = 50:33); B, 100% beef (lean:fat = 50:33); C, 100% carabeef (lean:fat = 50:33).

[b]Colour. 9, dark; 1, colourless. Flavour: 9, excellent; 1, extremely poor. Off-flavour: 9, very strong; 1, none. Saltines: 9, extreme; 1, none. Tenderness: 9, very tender; 1, extremely tough. General acceptability: 9, like extremely; 1, dislike extremely.

Table 2. Mean taste panel score for "caldereta."

Trait[a]	Goat meat	Beef	Carabeef
Flavour	2.91	2.94	3.02
Off-flavour	4.63	4.57	4.71
Consistency	2.77a	3.00a	2.60b
Tenderness	6.23b	2.37b	2.28b
Overall acceptance	7.31	7.20	7.20

Note: Values in the same row followed by the same letter(s) are not significantly different.
Source: Adapted from Reyataza (1978).
aFlavour: 1, undesirable, strong; 3, desirable; 5, undesireable, weak. Off-flavour: 5, none; 1, very strong. Consistency: 1, undesirable, very thick; 3, just right; 5, undesirable, very thin. Tenderness: 9, very tender; 1, extremely tough. Overall acceptance: 9, like extremely; 1, dislike extremely.

Traits of processed goat meat

Goat ham

Goat ham was selected to represent intact processed meat. Production of goat ham was studied by Tucay (1974). The processed ham has a moisture content of 68.86%, an ash content of 5.48%, 111.92 ppm nitroso pigments, an 8.37% shrinkage during processing, a 15.22% shrinkage during soaking, and, after 2 weeks of aging, a 22.55% shrinkage. These values are similar to shrinkages observed in pork hams. The flavour and general acceptability scores of the goat meat hams were high, no off-flavour was detected, and the only criticism of goat ham was that it was tough and dry. A similar study conducted by Arciaga (1982) found that high-quality ham may be produced using the dry-cured fried, dry-cure boiled, sweet-pickled dried, or sweet-pickled boiled methods of preparation. Based on all these observations, it can be concluded that goat meat can be prepared into hams.

Corned meat

Corned meat is a cured, comminuted product. Corned beef is darker than both corned carabeef and corned goat meat. For colour, a score of about 6 is ideal; corned goat meat was the closest to this score (Table 3). There was a slight off-flavour in corned goat meat and corned carabeef. This off-flavour is probably undetectable by common consumers because corned carabeef is a popular food item in the Philippine markets. Corned goat meat has less of an off-flavour than corned carabeef (Table 3).

Meat loaves

Meat loaves are comminuted, emulsion products. Argañosa and Bandian (1979) found no significant differences in moisture, crude protein, pH, cooking stability, or cooking yield of meat loaves made of goat meat and beef (Table 4). Meat loaves made with beef had higher percentages moisture and ash but had lower ether extract and water-holding capacity. Meat loaves made with goat meat had significantly lower flavour and general acceptability scores than those made with beef (Table 4). Tenderness and juiciness scores were not significantly different between goat meat and beef loaves. Goat meat loaves had a significantly better appearance than beef loaves.

Because of the lower overall quality of the meat loaves where 100% of the beef was replaced by goat meat lean, Argañosa and Bandian (1979) replaced beef

Table 3. Mean taste panel score of corned goat meat, corned beef, and corned carabeef.

Trait[a]	Corned goat meat	Corned beef	Corned carabeef
Colour	6.17c	8.00a	6.96b
Flavour	6.00c	7.88a	6.67b
Off-flavour	1.42ab	1.00b	1.71a
Saltiness	5.08	5.34	5.00
Tenderness	6.96ab	7.29a	6.75b
Juiciness	7.00	7.21	6.96
General acceptability	6.50b	7.96a	6.75b

Note: Values in the same row followed by the same letter(s) are not significantly different.
Source: Adapted from Argañosa and Bandian (1979).
[a]See Table 1, footnote b.

Table 4. Selected traits and sensory characteristics of goat meat and beef meat loaves.

Trait	Beef[a]	Goat[b]
Moisture (%)	59.80	50.71
Ash (%)	2.15	1.90
Ether extract (%)	20.58	21.64
Protein (%)	12.47	12.62
pH	5.75	5.82
Water-holding capacity	1.61	2.28
Taste panel scores		
Appearance	7.18	8.18
Flavour	7.50	6.68
Tenderness	7.40	7.20
Juiciness	6.92	7.30
General acceptability	7.85	7.15

Source: Adapted from Argañosa and Bandian (1979).
[a]Beef, 60%; pork lean, 10%; fat, 30%.
[b]Goat meat, 60%; pork lean, 10%, fat, 30%.
[c]Total area/meat area
[d]See Table 1, footnote b, and Table 2, footnote a.

with goat meat at rates of 100, 75, 50, and 0%. Then mean flavour scores for meat loaves made with 75 and 50% goat meat did not differ significantly. Both were higher than that of meat loaves made with 100% goat meat, however. There was no significant difference in juiciness among the four meat loaves. These results suggest that goat meat can replace beef at a rate as high as 75% in meat loaf products. Similar results were obtained by Eggen et al. (1973) in wieners.

Fresh and smoked sausages

Fresh and smoked sausages are comminuted, nonemulsion products. Argañosa et al. (1979) found that the tenderness of sausages containing 0, 50 , 60, and 70% goat meat was similar (Table 5). The sausages containing 70% pork lean and 30% pork fat had the best flavour but worst juiciness and colour. No significant differences were observed in the saltiness and general acceptability of the products. Similar trends were observed in smoked sausages. Other studies have produced similar results (Esguerra 1972; Argañosa and Bandian 1979; de Guzman 1980).

Table 5. Sensory characteristics of four fresh sausage formulations.

Trait[a]	A	B	C	D
Tenderness	6.50	6.93	6.83	6.68
Flavour	6.62a	6.84a	7.02a	7.55b
Off-flavour	1.95a	1.55ab	1.40bc	1.13c
Juiciness	6.53a	6.87a	6.78a	4.78b
Colour	8.13a	8.05a	7.93a	5.58b
Saltiness	5.05	4.85	4.87	5.08
General acceptability	6.65	7.03	6.87	7.02

Note: Values in the same row followed by the same letter(s) are not significantly different. A, 70% goat meat lean, 30% pork fat; B, 60% goat meat lean, 40% pork fat; C, 50% goat meat lean, 50% pork fat; D, 70% pork lean, 30% pork fat.
Source: Adapted from Argañosa et al. (1979)
[a]See Table 1, footnote b.

Table 6. Selected processing characteristics of beef, carabeef, lamb, and goat meat.

Parameter	Beef	Carabeef	Lamb	Goat meat
Oil/100 g protein (mL)				
Young	20.96	22.26	24.12	22.90
Old	21.28	20.92	22.32	22.64
Fat released/100 g emulsion (g)				
Young	0.54	0.65	0.66	0.55
Old	0.44	0.88	0.58	0.44
H_2O released/100 g emulsion (g)				
Young	24.2	25.0	23.0	25.0
Old	21.9	23.3	22.2	20.3
Salt-soluble protein (%)				
Young	2.23	3.19	3.52	3.39
Old	2.97	2.59	3.74	3.58
Extractable protein[a]				
Young	13.20	15.06	17.29	16.34
Old	13.55	11.60	17.20	17.22
Moisture/protein ratio				
Young	3.55	3.57	3.75	3.69
Old	3.50	3.38	3.48	3.66
pH				
Young	5.53	5.58	5.87	5.69
Old	5.51	5.49	6.02	5.91
Viscosity of emulsion with 100 mL oil				
Young	1600	1800	3900	2900
Old	1400	1300	4300	3000
Viscosity of emulsion after homogenization				
Young	5300	4800	4950	4700
Old	5400	5100	5150	4500

Source: Turgut (1984).
[a]Salt-soluble protein/total protein.

Goat meat pickles

Padda and Sharma (1982) prepared meat pickles from goat meat and found them to have a high overall acceptability. Therefore, goat can be used in the manufacture of pickled products.

Processing characteristics

The properties of various meat proteins to stabilize fats and oils have been investigated in relation to the processing characteristics of different types of meat. The emulsifying capacity of water- and salt-soluble meat proteins is determined as a function of various parameters such as protein concentration, pH, temperature, ionic strength, and the nature of the neutral salts in the aqueous media (Chattoraj et al. 1979) Turgut (1984) found that lamb and goat meat can emulsify similar amounts of oil per 100 g protein, amounts higher than beef and carabeef (Table 6). The stability of the emulsions measured as fat and water released was similar regardless of the meat used. The salt-soluble and extractable protein contents of goat meat were similar to those of beef and lamb and were higher than those of carabeef. The moisture to protein ratio trend was similar to that of the salt-soluble proteins. The viscosity of emulsions with 100 mL oil and after homogenization was greatest with goat meat followed by lamb, carabeef, and beef (Table 6).

Chattoraj et al. (1979) compared the capacity of water- and salt-soluble proteins to emulsify peanut oil at different protein concentrations in an aqueous medium. They found that, at a given concentration, the maximum phase–volume ratio of oil in the emulsion was in the following order: goat = chicken > lamb = pork. For pure actomyosin, the order was as follows: goat = lamb > pork = chicken.

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Discussion

The first paper in this session dealt with the nutritional value of goat meat. There is an extreme paucity of information in this area. In Asia, meat from 1- to 2-year-old goats is preferred. Therefore, efforts should be directed at maximizing the production and increasing the nutritive value of goat meat. Recently, the gap between consumption and production has increased significantly. Goat meat is comparable with other meats with respect to moisture, protein, and ash. It contains more arginine, leucine, and isoleucine and adequate amounts of essential amino acids. There is little information on the vitamin and mineral contents of goat meat. Goats have less subcutaneous fat but more internal fat than sheep. The high collagen content of goat meat may be one reason for its toughness.

The discussion following this presentation centred on the causes of taint and the reasons for the present shortage of goat meat. The presence of branched fatty acids (capric and caprylic acids) and the dressing procedure may contribute to the tainting of meat. Drought and the slaughter of underage animals have contributed to the shortage, inadequate supply, and high price of goat meat. It was felt, however, that several interacting factors are responsible for the shortage; this needs to be studied urgently. The discussion also highlighted that the goat population has not kept pace with the increasing human population.

The second paper of this session discussed carcass quality and methods of slaughter. The system of slaughter in New Zealand was described and the qualitative characteristics of a goat carcass (including high muscle and low fat contents) were pointed out. During the discussion it was mentioned that whereas there are minimum standards of carcass hygiene, the definition of carcass quality (in terms of composition, palatability, and hygiene) depends on consumer preferences and market requirements. In Malaysia, the maximum fat content of a goat carcass is about 8%. the optimum age of slaughter was also discussed. It was agreed that this also depends on market preferences. In Pakistan (Sind Province), young goats (6–7 months) are preferred.

The final paper of this session dealt with processing, storage, and organoleptic qualities of goat meat. Meat quality was defined as the degree of excellence of the product. A meat product must be attractive, appetizing, nutritious, palatable, and acceptable after cooking. An ideal meat product must also satisfy the numerous functional roles in fabrication and processing. Goat meat is generally brick red with white fat. There is little information about ideal colour and market preferences concerning goat meat. The Philippines does not have a great preference for goat meat. Goat has less flavour and tenderness than other meats but has an acceptable level of juiciness. Age and sex are known to affect organoleptic qualities. Although the meat of mature goats is juicier and more flavourful, it is less well accepted. Goat meat blends well in many Philippine recipes; it also has good processing characteristics, high acceptability scores, and can be used in many processed products. Its suitability for processing is due to its good emulsifying qualities, soluble proteins, and high emulsion stability.

The discussion following this presentation centred on the reliability of organoleptic tests. It was felt that a well-trained taste panel group could evaluate meat without bias. The amount of flavour, tenderness, and level of fat in the meat, however, will influence changes in carcass composition among countries.

Session III

Country Case Studies: Issues and Problems

Goat meat production in Bangladesh

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Abstract: *Goats play a crucial role in the subsistence economy of smallholders in Bangladesh. They provide a substantial amount of meat to the people of Bangladesh. An important goat breed in Bangladesh is the Black Bengal. This breed is distributed throughout the country. Black Bengal matures around 8–9 months of age, and the average mature weight is 15–18 kg in the male and 10–12 kg in the female. Because of limited land resources, goats feed mainly on wild leaves and plants and scavenge on a variety of waste feed materials. Goats of different sexes and ages are sold in the weekly village market. Prices in the villages are about 50% of those in the urban areas. Indiscriminate slaughter of goats of various ages and sexes is prevalent, with a serious loss of breeding animals. Educational and financial support of the people is necessary to increase their awareness of the qualitative and quantitative characteristics of goat meat and of the importance of animal proteins in human nutrition.*

Résumé: *La chèvre joue un rôle crucial dans l'économie de subsistance des petits agriculteurs du Bangladesh et représente pour les habitants de ce pays une source substantielle de viande. Une des grandes races caprines du Bangladesh est la Black Bengal, que l'on retrouve partout dans le pays. Cette chèvre arrive à maturité vers l'âge de 8 ou 9 mois; son poids moyen est de 15 à 18 kg chez le mâle et de 10 à 12 kg chez la femelle. La rareté des ressources l'oblige à se nourrir surtout de feuilles, de plantes sauvages et de déchets alimentaires. Chaque semaine, on se rend au marché du village pour vendre des chèvres des deux sexes et de tout âge; les prix y représentent environ 50 % de ceux demandés dans les zones urbaines. L'abattage de chèvres sans distinction d'âge ou de sexe est fréquent, d'où un manque important de bêtes pour la reproduction. On doit fournir un programme d'éducation et une aide financière à la population si l'on veut la sensibiliser aux aspects qualitatifs et quantitatifs de la viande caprine et à l'importance des protéines animales dans l'alimentation.*

Resumen: *Las cabras desempeñan un papel decsivo en la economía de subsistencia de los pequeños agricultores en Bangladesh. Estos animales proporcionan una cantidad substancial de carne a los habitantes de este país. Una importante raza de caprinos en Bangladesh es la Bengala Negra (Black Bengal). Esta raza está distribuida a todo lo largo del país. Los especímenes de Bengala Negra alcanzan madurez alrededor de los ocho a nueve meses de edad, y el peso promedio que tienen de adultos es de 15 a 18 kg para el macho y de 10 a 12 kg para la hembra. Debido a recursos de tierra limitados, las cabras se alimentan fundamentalmente de hojas y plantas silvestres y hurgan para alimentarse en una variedad de materiales alimenticios de desecho. Las cabras de diferentes sexos y edades se venden en el mercado semanal de la aldea. Los precios en la aldea son de aproximadamente el 50% de los que existen en las áreas urbanas. La matanza indiscriminada de caprinos de varias edades y sexos abunda, provocando una seria pérdida de animales de crianza. Es necesario apoyar educacional y financieramente a esta probación para aumentar su consciencia de las características cualitativas y cuantitativas de la carne de cabra y de la importancia de las proteínas animales en la nutrición humana.*

Bangladesh is the largest delta in the world and is situated between 20.70 and 26.80°N and 88.01 and 92.75°E. The population of Bangladesh is about 100.5 million and it covers an area of about 144,000 km^2. The population is 15.2% urban and 84.8% rural. The literacy rate in both sexes is about 23.8%. There are three main seasons: summer (March–June), monsoon (July–October), and winter

(November–February). In the summer, maximum ambient temperature is about 34.1°C and the minimum is about 20.8°C, with corresponding winter temperatures of about 28.6 and 11.0°C. The average rainfall varies from 1179 to 4017 mm. The humidity is about 99% in July and about 36% in December. Bangladesh is a riverine country and its topography varies from hilly to medium, low, and very low lands (BBS 1986).

Distribution and importance of goats

In a survey of Bangladesh's farming project areas, 17 types of farms were detected (Saadullah and Das 1986): 1.5% of landholders raise goats exclusively; 31.5% of landholders raise goats in addition to other livestock. About 60% of farmers with a landholding of up to 2 ha keep goats (Saadullah and Das 1986). In another study in southeastern Bangladesh in two Upa-zillas involving 200 households, Haque and Rahman (1983) found an average of 6.7 goats per farm family; this study was confined to goat raisers. It was also reported that the larger the family, the greater the ownership of goats. In large families, the youngsters, particularly children about 8 or 9 years of age, take care of the animals to earn money.

Goats are common among small, marginal, and landless farmers. They are also reared on large farms. Rearing management is performed by the homemakers and the children in the rural areas. Because of their size, easy management, small space requirement, high fertility, short generation interval, and small investment, goats are a favourite with the people of Bangladesh.

Dwarf goats are especially adapted to the climatic conditions of Bangladesh (Devendra and Burns 1983). Bangladesh lies in the humid tropic zone in which the goat population is well distributed. There are about 10.2 million goats in Bangladesh, representing 29.9% of the total national livestock population (cattle, 66.9%; buffalo, 1.7%; sheep, 1.5%).

Staple foods and nutritive food are required by the people. Staple foods in Bangladesh include rice supplemented with wheat and are meant to sustain life. Nutritive foods include meat, milk, eggs, and fish and are meant to sustain good health. Because of a lack of nutritive food, 90% of the people of Bangladesh are undernourished. In 1984/85, the average per capita meat consumption was 3.98 kg/year (Table 1). The current retail price of beef is USD 1.50–1.63/kg; goat meat costs USD 1.95–2.12/kg. These prices are almost double the minimum daily wage rate in Bangladesh of USD 0.84–1.14 (BBS 1986). The data reflect the present high price of meats and inadequate supply of meat in the country. The daily supply of animal protein from meat, milk, and eggs in Bangladesh is about 2.3 g/head.

Table 1. The average per capita consumption of meat, milk, and eggs.

Year	Population ($\times 10^6$)	Meat (kg)	Milk (L)	Eggs (no.)
1981/82	91.6	3.70	7.66	14
1982/83	93.6	3.78	8.47	15
1983/84	95.7	4.00	8.68	14
1984/85	99.2	3.91	9.71	11

Source: BBS (1986a).

Table 2. Production ($x10^3$ t) of beef, buffalo, mutton, and goat meat in Bangladesh.

	1974-76	1981	1982	1983	Contribution (%)
Beef	142	189	194	195	77.7
Buffalo meat	3	6	6	6	2.4
Mutton	2	2	2	2	0.8
Goat meat	27	46	47	48	19.1

Source: FAO (1983).

This constitutes about 45% of the total animal protein supply (5.0 g/day); the remaining 2.7 g/day comes from fish (World Bank 1981).

The availability of land resources for cultivation of feeds and fodder and for grazing animals is gradually decreasing. Because of the complex situation, farmers maintain small animals (goats and sheep), poultry, and ducks in preference to larger livestock. Because of their adaptability and hardiness, goats are preferred over sheep in Bangladesh (sheep account for only 1.5% of livestock population).

The most popular goat breed in Bangladesh is Black Bengal. Compared with other breeds, Black Bengal has some distinct features: meat quality, prolificacy, skin quality, and disease resistance. The breed is distributed throughout the country and its average size at maturity is 15–18 kg for the male and 10–12 kg for the female. Although being smaller than other breeds, this goat is very hardy and plays an important role in producing meat, milk, and skins. It accounts for about 19.1% of the livestock meat supply of Bangladesh (Table 2). The meat of Black Bengal is relished and in great demand.

Multiple births and regular kidding intervals are the most important economic features of Black Bengal. The increasing frequency of kidding and number of kids born per doe obviously indicates an increase in meat production (Devendra and Burns 1983). One female goat yields 250 g/day of milk and the lactation length is only 1–2 months. As a result, the milk yield often does not meet the requirements of the growing kids, especially in multiple births. In 1983, about 512,000 t of goat milk was produced (FAO 1983).

Black Bengal skins are also in great demand because of the superiority of the finished products. Hides and skins are Bangladesh's third highest export; they contribute about 12.1% to the total export earnings of the government. From July 1986 to June 1987, the foreign exchange earned through the export of hides and skins amounted to USD 100.3 million (EPB 1987).

Pattern of production

Goat production in Bangladesh has increased at a rate of 3% per year since 1977 (BBS 1986b). The reasons behind this increased production are associated with the deterioration of the socioeconomic condition of the population and the 54% increase in landless households since 1971 (BBS 1985). Because of this, farmers are unable to keep large animals for their sustenance and are more inclined to rear goats.

The high unemployment in Bangladesh has resulted in the younger generation keeping goats to earn money. Since 1970, farm resources (land, labour, and

Table 3. Average retail price (USD/seer)[a] of meats in Bangladesh from 1980/81 to 1986/87.

	1980/81	'81/82	'82/83	'83/84	'84/85	'85/86	'86/87
Beef[b]	0.70	0.77	0.77	0.82	1.10	1.47	1.63
Goat meat[b]	0.91	1.06	1.05	1.19	1.55	1.96	2.30
Chicken (live)[b]	0.82	0.92	0.89	1.13	1.38	1.30	1.50
Boiler (dressed)	-	-	-	-	-	1.96	2.30

Source: BBS (1986a).
[a] 1 seer = 0.9331 kg.
[b] Superior quality meat.

capital) have been primarily used for food and cash crop production. Cropping of the land is too intense at around 150% (FAO/World Bank 1983). Because of poverty and the acute shortage of land, farmers have been forced to rear goats as scavengers, without investment of any kind.

The primary objective in rearing goats is to produce meat of superior quality. Black Bengal meat is very tender and flavourful. As a result, the economic importance of goat meat compared with other meats will remain high. Goat meat is also an important ingredient in many social and cultural dishes of Bangladesh. All parts of the carcass (e.g., vertebra, loin, rump, thigh) are used for a variety of rich dishes at all occasions. Therefore, the price of goat meat is higher than any other meat in the market (Table 3). The small carcass size, availability, and easy processing makes goat meat more suitable than other meats for immediate family consumption (Devendra and Burns 1983).

Marketing systems of livestock and livestock products

Traditional marketing systems for goats and goat meat exist in Bangladesh. There are three patterns of marketing (Fig. 1). First, live animals are displayed in the weekly village market stalls. These animals are sold wholesale by haggling over prices. Second, agents, middlemen, or wholesale dealers visit the rural areas and advance cash to the villagers for maintenance of the goats. The animals are collected later for sale. Third, meat is sold in the big supermarkets in the urban and rural-fringe areas. Traditional traders (Faria) procure animals in the market at scheduled times in the weekly bazaar from stall owners and butchers. All types of goats, irrespective of age and sex, are displayed in the market.

During Muslim festivals, such as Eid, castrated bucks (khashi) about 1.5 years old are in high demand for sacrificial purposes. These khashi goats are sold at the weekly market at high prices, which benefits the landless goat producers. Most animals are slaughtered in the municipal slaughterhouses in the urban areas, where municipal meat inspectors certify the carcasses suitable for human consumption. Management, marketing, and slaughtering are unscientific and traditional, and require significant improvement. During natural calamities, such as floods, the people sell their animals at low prices because of the hardship of maintenance.

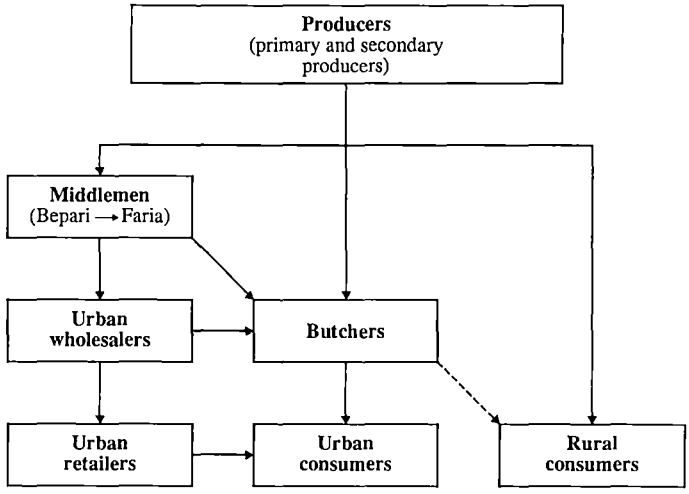

Fig. 1. Marketing pattern of goat in Bangladesh. Bepari are businessmen and Faria are the traditional traders (brokers).

Goat meat production

Limitations to increased production

The indiscriminate construction of huts and houses to accommodate the increased human population, the development of highways and embankments, the development of various independent sectors, the establishment of brickyards, and the natural erosion of the rivers greatly limit the available land for increasing livestock production in a systematic manner. The poverty of the farmers, in many cases, does not allow for the proper development and management of the goats, which subsist by scavenging. This also damages crops, vegetables, and fruit trees.

The indiscriminate slaughter of all types of animals without reference to age, sex, disease, or productivity is common in Bangladesh. Thousands of goats are slaughtered every day before they reach maturity. For example, kids around 4–5 months old weighing 4–5 kg and a high percentage of females around 8–10 months old are often slaughtered. There are also no standards for grading the meat, and the producers and consumers are subject to the haphazard methods of production.

The unavailability of breeding bucks is a serious problem limiting the multiplication of goats. Owners often do not have to breed bucks to service a doe in heat, with the result that reproduction is delayed and multiplication is limited.

Wastage of animals and meat

Because of the absence of grading methods for meat, by-products such as skin, blood, etc., are sold at low prices and tremendous losses. Protection against diseases, both contagious and noncontagious, is very limited in rural areas. The inevitable loss of kids as a result of disease accounts for 50% of the total goat production in Bangladesh.

Scrapings of the meat cut in the market by the butchers are collected and sold as meat balls at a very nominal price causing a loss to the meat dealers. Because of the unscientific method of slaughter, endocrine glands, which could be used in the manufacture of drugs, are discarded. The skin, hooves, ears, feet, etc., are also thrown away by many butchers.

Steps to increase meat production

Farmers must have access to financial support from various government agencies and private organizations. They must also get fair prices for their products.

The hilly areas of Bangladesh, such as Sylhet, Comilla, Chittagong, Rangamati Hill tracks, Tangail, and Shoal areas (char areas) of various districts such as Rajshahi, Noakhali, Kustia, Bagerhat, and Khulna, are the main areas of goat production. In the districts of Rajshahi, Noakhali, Bagerhat, Jessore, and certain parts of Mymensingh, goats are commonly kept in groups of three or four. Increased encouragement to rear goats in these areas must be given.

There is a need for more intensive research and development on goats. Wider national and international support is required.

Cooperative organizations must be formulated by the villages in cooperation with banks and other organizations to promote goat rearing and marketing, and the collection of hides and skins, bones, and blood in a systematic manner. Antemortem and postmortem examinations of the carcasses must be adhered to.

Practical lessons on goat rearing and agriculture in general should be included in the syllabuses of primary and secondary schools.

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Goat meat production in China

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Abstract: *China has one of the largest goat populations in the world. There are 11 meat breeds totaling 11 × 10^6 head. Goats are found throughout China, irrespective of climate, altitude, vegetation, or region. China annually produces approximately 476 × 10^6 kg goat meat. Although this production comes from all regions of the country, the largest amount comes from southern China. To accelerate goat meat development, the following measures are suggested: regional plans and commercial production bases should be established, flock structure should be regulated, intensive fattening operations should be initiated, breeding farms and mating services should be established, fodder resources should be rationally utilized and developed, the scientific knowledge on improved management methods must be disseminated, and marketing outlets should be developed.*

Résumé: *La Chine possède l'un des cheptels caprins les plus importants au monde. On y compte 11 races de boucherie totalisant 11 × 10^6 têtes. Il y a des chèvres partout en Chine, quel que soit le climat, l'altitude, la végétation ou la région. Chaque année, la Chine produit environ 476 × 10^6 kg de viande caprine. Cette production provient de toutes les régions, mais surtout du Sud du pays. Afin d'accélérer la production de viande caprine, on suggère les mesures suivantes : établissement de plans régionaux et de l'infrastructure commerciale de base nécessaire à sa production, régulation de la structure des troupeaux, engraissage intensif, création de fermes d'élevage et de services d'accouplement, utilisation et exploitation rationnelles des ressources fourragères, diffusion des connaissances scientifiques relatives à l'amélioration des soins et création de points de commercialisation.*

Resumen: *China tiene una de las existencias más altas de cabras en el mundo. Hay once razas de carne que alcanzan un total de 11 × 10^6 cabezas. Independientemente de las condiciones climáticas, altitud, vegetación, o región, se encuentran cabras a todo lo largo de China. Este país produce actualmente cerca de 476 × 10^6 kg de carne de cáprinos. Aun cuando esta producción proviene de todas las regiones del país, la mayor cantidad viene del sur de China. Para acelerar el desarrollo de la carne de cabra se sugieren las siguientes medidas: deben establecerse planes regionales y bases de producción comerciales, debe regularse, la estructura del rebaño, deben iniciarse operaciones intensivas de engorde deben establecerse granjas de crianza y servicios de apareamiento, deben desarrolarse y utilizarse racionalmente las fuentes de forrajes, debe diseminarse el conocimiento científico sobre los métodos de administración mejorados y se deben desarrollar agencias para la comercialización.*

There were 16 × 10^6 goats in China in 1949. Since then, the population has grown rapidly to 45 × 10^6 in 1958, 68 × 10^6 in 1977, and 78.5 × 10^6 in 1984. China now has the largest goat population in the world (Huang 1985).

Goats are found throughout China, irrespective of climate, altitude, vegetation, or region. In 1984 goats were distributed as follows: farm region, 63%; pastoral region, 22%; mixed farm region and pasture, 15%. In geographical terms, 41% of the population is in the south and 59% is in the north.

A variety of goat products, including down, fibre, meat, skins, and casings, are produced in China. In addition, goat dung is an important fertilizer. The annual outputs of goat down, fibre, and goat milk are about 3.8 × 10^6, 14.1 × 10^6, and

257.8 $\times$ 10^6 kg, respectively. The down production is the largest in the world, annually accounting for 33–50% of the international market (Huang 1985).

With the progress in and popularization of science and technology, great attention has paid to developing herbage-fed livestock in the last 10 years. The goal of goat raising has gradually changed from self-sufficiency to commercial production. For example, dairy goats are now found in many towns and suburbs, supplying cities with abundant fresh milk. There has also been a rapid increase in goat meat production.

Goat meat production

China annually produces roughly 476 $\times$ 10^6 kg goat meat (Huang 1985), which does not meet the demand. Although the meat is produced throughout China, the largest amount is produced in southern China. In 1984, 7.58 $\times$ 10^6 kg goat meat was produced in Yunnan. It was about 1.6% of the province's total meat production. Most parts of southern China are subtropical or tropical with a warm, humid climate: the plant-growth period is long, forage and fodder are abundant, and goats grow well and have a high reproductive rate. Some well-known breeds of meat goats are produced is southern China: e.g., the Matou goat in Hunan and the Leizhou breed in Guangdun.

Marketing of goat meat

Goats are sold in three ways. First, goats are sold for local consumption ($>60\%$ of total goat meat is for home consumption) or to other farmers in the region. Second, the meat may be sold by the farmers to nearby large and medium-sized cities through trade departments. Third, in a few districts, the goat meat is produced specifically for foreign trade. The price of goat meat is similar to that of beef but is lower than that of pork.

In China, there are two methods of preserving goat meat. In the northern pastoral regions, most of the meat is sold outside the region. To avoid losses or death during transportation of the animals, they are slaughtered and processed on the spot and frozen by the natural low temperatures in early winter. In the other regions of China, quick mechanical freezing and special cold storage are employed. This method is mainly practiced near the cities or in large meat-processing factories.

Meat goat breeds

There are 25 goat breeds in China (Jiang 1982); 11 are meat breeds (Table 1) totaling 11 $\times$ 10^6 head.

Huai

The Huai goat is mainly found in the plain farm region of southeast Henan (Table 1) which enjoys a warm-temperature monsoon climate suitable for crop growth. Pen feeding is prevalent. The Huai goat is a medium-size goat (Table 1). The young goat grows rapidly and, by 9 months, has reached 90% of adult weight.

Table 1. Selected characteristics of the 11 goat meat breeds of China.

Breed	Region	Live weight at maturity (kg)		Kidding %	Net meat rate (%)[a]	Average dressing %
		Buck	Doe			
Banjiao	East Sichuan	40	30	184	42	55.7
Chengdu Ma	West Sichuan	43	33	210	38	54.0
Du An	Northwest Guanxi	40	27	130	-	47.5
Fuqing	East coast, Fujian	30	26	180	-	56.0
Guizhou White	Northeast Guizhou	33	31	274	40	57.9
Haimen	Yangtse Delta	30	20	-	-	46.0
Huai	Southeast Henan	35	26	-	40.5	49.8
Leizhou	Leizhou Peninsula	49	43	203	-	46.0
Longlin	West Yunnan	50	43	122	-	52.5
Matou	Hunan and Hubei	44	34	200	-	60.0
Shanxi White	South Shanxi	33	27	259	40	>50.0

Source: Cheng (1985).
[a]Percentage meat on carcass of adult whether.

Goats are slaughtered from 7 to 9 months of age. A 7- to 9-month-old wether has a mean live weight of 21.9 kg, a carcass weight of 10.9 kg, and a net meat weight of 8.9 kg. Every year, 3.5×10^6 goats are slaughtered for meat in Henan province.

White Goat

The White goat is found in the subtropical agricultural area of south Shanxi (Table 1). The goat grazes in the summer and autumn and is pen fed in the winter and spring. The White goat is a medium-sized goat (Table 1). The kid grows and develops rapidly. The meat is tender and delicate.

Matou

The Matou goat is found mainly in the subtropical western mountain regions of Hunan and Hubei (Table 1). There are wide areas of natural grassland for summer and autumn grazing (ABXYR 1975); however, in the winter and spring pen feeding is necessary. Adult Matou goats are large (Table 1). Some individuals may reach 100 kg. A 7-month-old kid has an average weight of 23.31 kg and a dressing percentage of 52.3%; the carcass weighs 10.5 kg and the fat, 1.7 kg.

Chengdu Ma

The Chengdu Ma goat is found in the subtropical western plain and hill regions of Sichuan Province (Table 1). Adult Chengdu Ma goats are large (Table 1) and the meat is of good quality with evenly dispensed fat content.

Banjiao

The Banjiao goat is found in the subtropical eastern mountain region of Sichuan Province. Located 450–1500 m above sea level, the mountain shrublands and grasslands allow year-round grazing. Some supplementary feeding is necessary in the winter and spring. Carcass weight is 20.2 ± 4.6 kg; of this, 1.5 ± 0.1 kg is mesenteric fat and 16.4 ± 4.6 kg is meat.

Guizhou White

The Guizhou White goat lives in the subtropical northeast mountain region of Guizhou, where the altitude is 500–1200 m. This region has a wide area of shrublands and grasslands to support goat grazing. At 1 year of age, males are, on average, 24.1 kg before being slaughtered. The carcass weighs 11.5 kg, of which 1.4 kg is mesenteric fat and 8.8 kg is meat. The dressing percentage of the 1-year carcass is 53.3% and the percentage of meat is 36.6%. The adult wether has a mean average weight of 47.5 kg and its carcass weighs 23.2 kg, including 4.3 kg mesenteric fat and 19.0 kg meat. The meat is of good quality with a weak odour.

Longlin

The Longlin goat lives in the subtropical western mountain area of Yunnan Province at an altitude around 1815 m. This area flourishes with shrubs and grasses and is suitable for grazing. The goat is large (Table 1): 1-year-old males average 37 kg; 1-year-old does, 33 kg. The meat is fine and tender.

Leizhou

The Leizhou goat is found in the tropical, evergreen Leizhou Peninsula and grazes in the hill region (Table 1). Kids grow and develop rapidly. The goat has a high reproduction rate, averaging 2 births/year.

Fuqing

The Fuqing goat lives in the subtropical, eastern coast belt of Fujian Province (Table 1). The mountain land and seaside are appropriate grazing areas. The Fuqing goat is a relatively small breed (Table 1); however, fattened wethers may reach 23 kg at 8 months and 40 kg by 18 months.

Du An

The Du An goat lives in the evergreen northwest mountain area of Guangxi Province (Table 1). Shrubland and grassland are sufficient for grazing.

Haimen

The Haimen goat grows in the subtropical Yangtze delta (Table 1). Because of the well-developed agricultural base in this region, there is a wide variety of material available to feed goats. This breed of goat is small (Table 1) and the delicious meat is fatty and tender with the fat evenly distributed.

Goat meat development

Regional plans and commercial production bases

Goat husbandry in China is rapidly developing, but needs to be better organized. Unfortunately, current productivity is low because of the nonspecialized production of most goat breeds. To improve this situation, regional planning for goat development is essential. Such planning is now under way. For example, it has been decided that the dairy goat will be developed for the suburbs of large and medium cities, the counties along railway lines, and the concentrated regions

of factories and mines. The goats in the northern pastoral areas will be developed largely for meat and down production. The wide southern area will be the main production base for goat meat (Huang 1985). In line with these developments, commercial production bases for meat in some provinces will also be established. Both specialized management and commercial production are essential for improved goat production.

Flock structure and intensive fattening methods

Although large numbers of goats are raised in some places, production is low. This low economic efficiency is a result of inappropriate flock structures (too many old goats and does). In northern China, goats lose a significant amount of fat in the winter and spring because of a lack of forages. For example, a 10-month-old goat in Pingquan County, Henan Province, that weighs 25.5 kg will lose 11.1 kg (44% body weight) over the 7 months of winter and spring. If the management of fattening and slaughtering could be improved, losses could be reduced considerably and meat production could be increased substantially. Supplementation with 70–100 g/day of corn and 1.2–2.5 kg/day of green hay to 19.2-kg grazing goats over a 6-month period would result in goats with a mean live weight of 31.8 kg. In southern China, this type of management is usually extended because a 6-month goat may reach 70–80% of adult weight. If additional forages are used, more rapid growth will occur.

Establishment of breeding farms

To improve meat productivity and fertility of native goat breeds through hybridization, breeding farms must be developed to provide the services of bucks and to provide artificial insemination services to accelerate goat meat production.

Utilization and development of fodder resources

Investigations on suitable forages and fodder resources to match the needs of goats is a matter of continuous effort. To efficiently use the natural pasture and facilitate the regrowth of grasses, rotational grazing is effective. Also, more grass seed should be produced. The practice of cutting and drying grasses for green hay in the summer and autumn or making green fodder for the winter also needs further investigation.

Dissemination of scientific knowledge

Goat production is currently limited by inadequate knowledge and the poor dissemination of extension efforts. There is an urgent need to popularize goat raising on a scientific basis. Aspects such as the reproductive system, grazing management, housing, ventilation and lighting, and health and disease prevention should be covered. These efforts should be coupled to more vigorous research and development.

Comprehensive utilization and marketing of goat

It will be difficult to increase economic efficiency without comprehensive utilization of goats and good marketing outlets. Therefore, further processing of the mutton, milk, skin, casing, and other products and their comprehensive utilization are necessary. Cooperative enterprises involving animal husbandry, industry, and commerce are equally important to broaden marketing opportunities. In

Shimen County, Hunan Province, the Dark-head goat, which has a large body and delicious meat, used to sell poorly. Since 1980, when a processing factory for slaughter was established and agreements with foreign trade departments were made, the sales of the meat and other products have significantly increased with high profitability.

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Goat meat production in India

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Abstract: *The goat population of India is maintaining a steady growth rate of 2.5% per year. In 1982, the goat population was 95 million, which is the highest of any livestock species. This paper describes the recognized goat breeds in India and their importance in the economy of farmers below the poverty line. Data on carcass yield, traits, and composition are presented. The patterns of trading and marketing of goats are also described. Goat meat is the most expensive of all meats in India and is increasing in demand. The price of the meat has increased 200–250% over the last 10 years. Meat production could be increased through genetic improvement, the development of the feed resources, the promotion of a higher kidding rate, improved health management (especially for kids), and improved hygiene at slaughter and marketing facilities. The export of mutton and goat meat is now only 0.2% of total meat production. The possibility for expanding this export is good, particularly to Middle East and Persian Gulf countries.*

Résumé: *Le taux de croissance annuel des troupeaux caprins de l'Inde se maintient à 2,5 %. En 1982, le cheptel était de 95 millions de têtes, le nombre le plus élevé de toutes les espèces de bétail. Le présent document traite des races caprines de l'Inde et de leur importance économique pour les éleveurs vivant sous le seuil de la pauvreté. On y trouve aussi des données sur le rendement, les caractéristiques et la composition des carcasses de chèvre de même que les structures de leur commercialisation. La viande caprine y est la plus chère de toutes les viandes et sa demande est à la hausse. En effet, son prix a augmenté de 200 à 250 % au cours des dix dernières années. Les améliorations génétiques, l'augmentation des ressources alimentaires, la promotion d'un taux de naissance plus élevé, de meilleurs soins (surtout pour les chevreaux) et une meilleure hygiène dans les abattoirs et les établissements commerciaux devraient permettre d'augmenter sa production. Les exportations de viande ovine et caprine ne représentent actuellement que 0,2 % de la production totale de viande du pays. Les possibilités de les augmenter sont bonnes, en particulier dans les pays du Moyen-Orient et du golfe Persique.*

Resumen: *La población de cabras de la India mantiene una tasa continua de crecimiento de 2,5% al año. En 1982, la población de cabras era de 95 millones, lo que constituye la más alta de cualquier especie de ganado. Este documento describe las razas reconocidas de cabras en la India y su importancia en la economía de agricultores por debajo del nivel de pobreza. Se presentan datos sobre el rendimiento de la canal, las características y la composición. Se describen también los patrones del comercio y comercialización de cabras. La carne de cabra es la más cara de todas las carnes en la India y su demanda está aumentando. El precio de la carne ha aumentado en un 200 y un 250% durante los últimos 10 años. La producción de carne se podría incrementar a través del mejoramiento genético, el desarrollo de recursos alimentarios, la promoción de un índice mayor de partos, un mejoramiento en la administración de las condiciones sanitarias (especialmente para los cabritos) y una mejor higiene en los mataderos para la comercialización. La exportación de carne de carnero y de cabra es ahora solamente el 0,2% del total de la producción carne. La posibilidad para expandir este rubro de exportación es buena, particularmente hacia países del Medio Oriente y del Golfo Pérsico.*

The domestic goats of India belong to genus *Capra* and most are believed to have descended from Bezoar (*Capra hircus*; Randhawa 1982). The Harrapan toys include goats; this suggests that goats were domesticated in India as early as 2000 B.C. Goats are an important component of the livestock industry and in the

socioeconomic life of the 40% of the population of India that live below the poverty line. Goats are primarily valued for their meat and skin; milk and fibre are also important products. Other products include blood, dung (used as fertilizer), bones, and horns.

The estimated goat population in India as of 1982 was 95 million (Table 1). About 35 million goats (43%) are slaughtered annually to produce 0.32×10^6 t of meat (35% of total meat production; FAO 1985). Goat meat (chevon) is the most expensive meat in India and is acceptable to people of all castes, creeds, and religions.

Goat breeds with varying capacities to yield milk, meat, and fibre have been developed in India primarily through natural selection. The goats of the temperate Himalayan region (where rainfall is low) grow fibres of good quality and possess the finest quality undercoat (Pashmina). All the milch breeds are found in north and northwest India. In south and west India, dual-purpose goats (milk and meat) are found. The highly prolific meat breeds are found in east India. There are about 20 well-defined breeds of goat apart from the nondescript regional goats (Table 2).

The goat population of India continues to increase (despite the 42% annual slaughter rate) by 2.5% per year (India 1982). Some states have shown growth rates of 5.9–31.3% over the last 10 years. However, with the advent of a canal system and traditional irrigated cultivation in the Punjab and Haryana, the goat population of these states has been significantly reduced with a consequent migration of people to adjacent states. Goat meat production in India increased 5.7%

Table 1. The population of goats in different states of India (1982).

State	Population ($\times 10^3$)	Area (km^2)	Goats (km^2)	% of goats
Andhra Pradesh	5534	276754	19.9	5.8
Assam	2030	78523	25.8	2.1
Bihar	12297	173876	76.7	13.0
Gujrat	3266	195984	16.6	3.4
Haryana	608	44222	13.7	0.6
Himachal Pradesh	1060	55673	19.0	1.1
Jammu and Kashmir	949	222236	4.3	0.9
Karnataka	4449	191773	23.2	4.7
Kerala	2004	48855	41.0	2.1
Madhya Pradesh	7582	443459	17.1	8.0
Maharashtra	7517	307762	24.4	7.9
Manipur	16	22356	0.7	-
Meghalaya	186	22489	8.3	0.2
Nagaland	62	16527	3.8	-
Orissa	4931	155842	31.6	5.2
Punjab	700	50376	13.9	0.7
Rajasthan	15389	342214	44.9	16.2
Sikkim	96	-	-	-
Tamil Nadu	5111	130069	39.3	5.4
Tripura	343	10477	32.7	0.4
Union Territories	181	119377	1.5	0.2
Uttar Pradesh	9690	294413	32.9	10.2
West Bengal	10915	87853	124.2	11.5
All India	94916	3281110	28.9	100.0

Table 2. Goat breeds and their distribution in India.

Breed	Population ($x10^6$)	Adult body weight (kg)[a]	
		Male	Female
	Temperate Himalayan region		
Gaddi	0.770	27.45±0.41	24.72±0.51
Chiangthani	0.040	20.37±0.24	10.75±0.15
Chegu	-	39.42±1.57	25.71±0.33
Shingari	-	25.23±0.56	20.35±0.41
	Northwestern region		
Jamunapari	0.580	44.66±1.89	38.03±0.63
Barbari	0.444	37.85±1.96	22.56±0.32
Kutchi	0.402	43.50±1.16	39.29±0.40
Jhakrana	-	57.80±3.50	44.48±0.52
Marwari	3.914	33.18±1.77	25.85±0.29
Sirohi	0.295	50.37±2.52	22.54±0.17
Beetal	0.159	59.07±2.82	34.97±0.52
Mehsana	0.735	37.14±1.51	32.29±0.38
Zalawadi	0.341	38.84±1.46	32.99±0.32
	Southern region		
Surti	0.280	29.50±0.50	32.03±1.31
Osmanabadi	0.219	33.66±2.73	32.36±0.55
Malabari	0.389	38.96±2.32	31.12±0.90
Sangamneri	5.692	38.37±2.44	28.97±0.49
	Eastern region		
Assam Hill	-	25.45±2.12	18.31±1.67
Bengal	2.200	32.37±2.74	20.38±0.16
Ganjam	0.448	44.05±0.13	31.87±0.37

Source: Acharya and Bhat (1984).
[a]Values are means ± SE.

per year from 1982 to 1985; over the same period, milk production increased by 29% and hide and skin production increased by 5% (FAO 1985).

Importance of goat meat production

Protein deficiency is prevalent in India. Of the total requirement of 1994 cal and 50.8 g protein per caput per day, only 192 cal and 5.8 g protein per caput per day are available from animal sources in India (1 cal = 4.19 J). Cattle, buffalo, sheep, goats, and pigs produce most of the meat; poultry, camels, rabbits, and other animals also contribute to the total meat production of India.

Carcass yield and meat characteristics

Information on the carcasses (yield, composition, and associated traits) of different breeds is meagre (Table 3). Carcass quality and dressing percent (D%) in some breeds have been studied (Srivastava et al. 1968; Johri and Talpatra 1971;

Table 3. Carcass traits (mean ± SE) of important goats and their crosses in India.

	Age at slaughter (months)	Pre-slaughter weight	Hot carcass weight (kg)	Dressing %[a]	Meat to bone ratio	Source[b]
Assam	6	8.37	3.38	40.4	-	1
Assam x Beetal	6	9.52	4.20	44.1	-	1
Barbari	12	17.83±0.66	9.09±0.49	50.7	77:23	2
	18	21.14±0.48	10.55±0.31	49.9	83:17	3
Barbari[c] x Jamunapari	11.5	16.87±5.82	7.70±2.45	45.6	77:23	4
Jamunapari x Barbari	11	14.90±0.94	6.43±0.23	43.2	76:24	4
Barbari Beetal[c]	12	21.89±7.90	11.05±4.95	50.0	80:20	4
Beetal x Barbari	12.8	22.35±2.88	11.11±1.67	49.8	81:19	4
Bengal	9	12.97±0.91	6.16±0.55	47.1	87:13	1
	12	11.59±0.84	5.17±0.44	44.6	87:13	3
Bengal x Beetal	12.4	18.10±1.99	8.57±1.30	47.4	82:18	1
Beetal x Bengal	13	19.36±4.76	9.53±2.73	49.2	76:24	4
Bengal x Jamunapari	9	13.99±0.75	6.60±0.00	47.2	-	1
	11.8	17.87±1.82	8.73±0.88	48.9	84:16	1
Sangamneri	9	11.50±1.45	5.08±0.74	44.2	-	5
	12	12.57±1.67	5.80±0.45	46.1	-	5
	18	18.00	8.00	44.4	-	5
Sangamneri x Angora	6	12.20±2.37	5.08±0.16	41.6	-	5
	9	12.85±0.57	4.42±0.42	38.4	-	5
	12	16.49±0.79	7.74±0.00	46.9	-	5
Sirohi	6	13.76±0.29	6.13±0.15	44.0	84:16	6
Sirohi x Beetal	6	15.31±0.36	6.92±0.18	44.6	84:16	6
Beetal	9	15.64±1.02	7.66±0.30	49.7	-	7
	12	20.33±4.83	9.38±2.74	46.2	77:23	3
Jamunapari	6	15.56±1.67	7.40±0.92	44.6	-	8
	9	24.00±1.16	11.56±0.65	48.2	-	3
	12	22.52±0.96	10.39±0.42	46.2	81:19	3
Beetal x Jamunapari	10.7	17.05±1.45	7.50±0.70	44.0	76:24	4
Beetal x Alpine	5	14.07±1.71	5.27±0.83	37.5	-	7,9
	9	18.31±0.41	9.46±0.36	51.7	-	7,9
Beetal x Saanen	9	18.76±0.81	9.43±0.44	50.3	-	7,9

[a]Live weight basis.
[b]1, AICRP (1985); 2, CIRG (1986); 3, RBSC (1983); 4, Singh and Sengar (1979); 5, ADHM (1967); 6, Misra (1984); 7, Chawla and Nath (1979a); 8, Khan et al. (1979); 9, Chawla and Nath (1979b).
[c]Improver breeds.

Singh and Sengar 1979). The average D% on a live weight basis ranges from 42.7 to 50.7%. Khan et al. (1979) studied carcass traits in Jamunapari kids slaughtered at 6 and 9 months of age and reported that the kids slaughtered at 9 months yielded heavier carcasses. The D% of 6- and 9-month kids on an empty live weight basis (preslaughter weight minus gut contents) were 54.2 and 55.8%, respectively. The eye muscle (longissimus dorsi) was also better developed in the kids slaughtered at 9 months. Johri and Talpatra (1971) and Saxena et al. (1974), however, found no significant differences in D% as a result of age at slaughter.

The results of Black Bengal × Jamunapari and Black Bengal × Beetal crosses have shown that Jamunapari × Black Bengal is superior to Black Bengal (Table 3). Alpine and Saanen crosses with Beetal slaughtered at 9 months show

Table 4. Carcass characteristics of Barbari kids reared under stall-fed and semi-intensive systems.

Carcass traits	Stall-fed kids	Semi-intensive feeding
Slaughter weight (kg)	19.5±0.6	17.8±0.7
Empty weight (kg)	17.0±0.6	15.2±0.7
Hot carcass weight (kg)	10.8±0.4	9.1±0.5
Dressing %		
Live weight basis	55.4±0.8	50.7±7.12
Empty live weight basis	63.6±0.8	59.3±0.9
Meat (%)	71.9±0.8	72.9±0.7
Fat (%)	7.7±0.9	4.3±0.5
Bone (%)	20.4±0.5	22.8±0.9

Source: CIRG (1986).

improved body weight at slaughter, carcass yield, and D% (Chawla and Nath 1979a). Alpine crosses were, however, superior in D% to Saanen crosses (Table 3). These results indicate that cross-breeding with exotics can improve both body weight and carcass yield. Carcass studies at the Central Institute for Research on Goats (CIRG) on Barbari kids showed that kids reared under feed lots had a superior body weight gain, yielded heavier carcasses, had a higher D%, and a larger eye muscle area than kids reared under semi-intensive feeding (Table 4).

Marketing and prices

Goat meat trading in India is, unfortunately, poorly organized: no government, semigovernment, or cooperative agencies are involved. Several producer states market their meat in other states. Middlemen operate the markets with entrenched business interests. Four of five categories of middlemen intervene between the farmers or owners (in distant villages) and the urban abattoirs, butchers, and meat shop owners. The field operators (who are in constant contact with producers and local livestock markets), wholesale dealers, transporters, brokers and commission agents, and financiers make a sale/purchase chain at various stages. The practices of intermediaries vary from one state to another. Goat producers, meat retailers (including the butchers), and consumers are at a disadvantage relative to the actual cost of production. The present price of goat meat is variable but ranges from INR 25/kg in the villages and small towns to INR 45/kg in the cities (in February 1988, 12.4 Indian rupees [INR] = 1 United States dollar [USD]). Ten years ago, the price ranged from INR 10 to 12/kg.

Goat meat production potential and limitations

India has the largest goat population in the world and there is great potential for increasing goat meat production by improving production methods and using the genetic base of nondescript breeds. The wide genetic variability in the goat population could be successfully utilized through progeny testing and application of superior bucks utilizing artificial insemination and frozen semen technology. Limited indigenous interbreed and exotic crossings have shown promising results (Tables 3 and 5). It is envisaged that a 40–60% increase in production can be achieved throughout India in 3–5 years. A 15–20% increase in goat meat produc-

Table 5. Carcass characteristics and yields of Indian goat breeds.

Adult body weight (kg)	Age at slaughter (months)	Preslaughter weight (kg)	Hot carcass weight (kg)	Dressing %	Meat to bone ratio
>35	6	14.98±0.99	6.73±0.71	44.9	80:20
	12	21.42±0.93	9.88±0.84	46.1	
25-35	6	11.48±0.71	5.34±0.13	46.5	80:20
	12	17.83±0.66	9.09±0.49	50.7	
<25	6	7.96±0.46	3.07±0.20	38.6	85:15
	12	11.59±0.84	15.17±0.44	44.6	

tion could also be achieved through improved feeding. After 12 months, Jamunapari and Barbari kids fed on a feed-lot system were 39.7 and 32.2% heavier than those fed on a range-grazing system, respectively (Fig. 1).

Feed resources

One factor that limits goat production in India is the deficiency of feed resources. Indian goats are primarily reared on range grazing. The grazing can supply 8,000 to 12,000 Mcal energy/ha per year (Sharma and Bhattacharyya 1987). Shrub and tree fodder is usually the feed choice for goats. Increased government attention is now being given to developing wastelands and denuded pasture and increasing the carrying capacity of the land. The present deficiencies of protein, energy, and dry matter are 50–75%, 50–60%, and 80%, respectively (J.L. Ogra, personal communication).

Seasonal breeding and kid mortality

Large breeds in north and west India generally reproduce once a year from August to October; at the best, there is a 25–30% twinning rate. Dwarf breeds, particularly in east India, reproduce twice a year and the annual kidding rate is 400% (Bhattacharyya 1982).

The mortality of kids as a result of diarrhoea (15–20%) up to the age of 3 months is a serious constraint to production. Intensive goat production is also often constrained by pneumonia and Johne's disease.

Prejudice and myths

There is a serious lack of understanding about the feeding behaviour of goats and their role in agricultural fields, natural forests, and hot and cold arid ecosystems. Administrators dealing with forests, the environment, and soil conservation are prone to identify goats, contrary to scientific findings, as an enemy to plants and soil. Some administrators believe that goats eat the leaves and shoots of every tree, that their saliva contains enough poison to kill a tree with a few bites, and that they uproot grass and promote soil erosion. The limited forest resource of India caters to the ever-growing needs of industry (including packaging for transport of perishable goods) and is a source of fuel for the rural population. It is unfair to only blame the "scapegoat" for the poor state of India's forests.

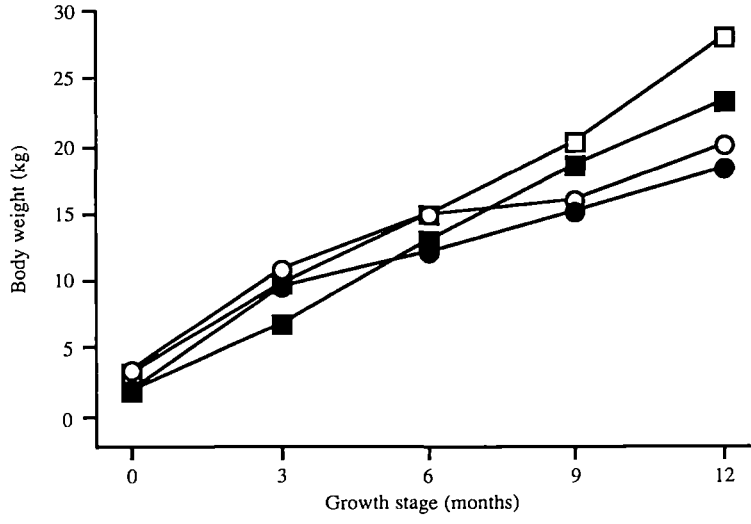

Fig. 1. Growth of Jamunapari (solid symbols) and Barbari (open symbols) under feed lot (squares) and range-grazing (circles) conditions.

Abattoir by-products and recoverable waste

Blood, serum, viscera, glands, bones, hides, hooves, ligaments, and tendons are some by-products obtained from goats. Limited commercial exploitation of these products for pharmaceutical and industrial use has been attempted (Rao et al. 1985). Methods of preparing casings for sausages, which have good export potential, have already been developed (Kondaiah et al. 1979).

Indian goats provide 75,600 t/year of skins. Goat and kid skins are generally used for making shoes, fancy leather goods, handbags, gloves, and garments. As a result of skin diseases, ectoparasitic infestation, and faulty handling, these skins receive lower gradings and fetch a low price in the international market. The annual loss is enormous and could be significantly reduced.

Export potential of goat meat

According to a recent estimate (Kalia and Rajapurohit 1987) for 1984/85, the production of goat meat was 0.55×10^6 t compared with 0.13×10^6 t for sheep. There is a large demand for both goat meat and mutton and the export of both meats as percentage of domestic consumption is only 0.21%. Since 1979/80, the export of goat meat and mutton has increased substantially (Fig. 2). By 1984/85, mutton and goat meat accounted for 31.4% of the total meat export. There is an increasing demand for lean meat in Middle East and Persian Gulf countries, implying an excellent possibility for further expanding the export market. Goat meat processing and product preparation is seldom done in India because of the high demand for raw meat.

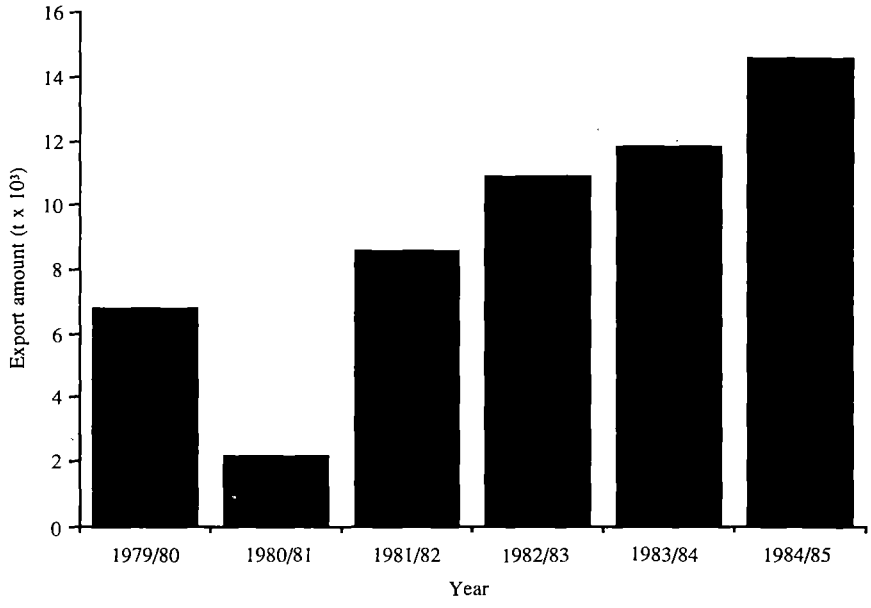

Fig. 2. Export of goat meat and mutton from India (1979/80–1984/85) (source: Kakia and Rajapurohit 1985).

Improvement in goat meat production

Increased goat meat production can be achieved through the following six strategies: development of three-tier agroforestry in all fallow wastelands; scientific breeding for improvement of body weight at slaughter, higher kidding rate, and better feeding efficiency; development of intensive stall-feeding systems and inherent temperament in animals; health management to control kid mortality; creation of an adequate infrastructure for efficient and hygienic slaughter and the recovery of by-products; and assured marketing through village cooperatives.

Wasteland development

Any livestock-production program needs a strong feed and fodder resource base. This can be accomplished by developing wastelands into agrosilvipasture and forage forestry. Many fast-growing, drought-resistant varieties of trees and shrubs (Table 6) can be introduced to the wastelands, involving a three-tier canopy of grass, shrub, and fodder trees and an intercropping system to provide maximum foliage or green biomass for feeding. Agricultural and industrial by-products and kitchen wastes are also important sources of nutrients in semi-intensive and intensive systems of management.

Breeding program

Breeding programs should aim at upgrading nondescript goats with compatible, recognized breeds, achieving higher body weights, better feeding

Table 6. Drought-resistant shrubs and trees for goats.

Shrubs	Trees
Zizyphus nummularia	*Prosopis cineraria*
Zizyphus rotundifolia	*Acacia tortalis*
Zizyphus jujuba	*Acacia arabica*
Capris aphylla	*Acacia jacquamowtii*
Calliyonum polygonides	*Acacia catachu*
Leucaena leucocephala	*Acacia singal*
Dichrostachys nutens	*Albizia lebbek*
Sesbinia grandiflora	*Malia arabirachta*
	Salvadera persica
	Salvadera oleodes
	Ficus religiosa
	Ficus bengalensis

efficiencies, and better kidding rates. Selective cross-breeding of recognized meat breeds with larger local and exotic sires will increase production.

Preventive health coverage

Preventive health coverage of goats is as important as it is to any livestock species. A higher survival rate, particularly for kids, and a low mortality of adults will facilitate increased meat production.

Hygienic slaughter facilities

Contrary to larger meat-producing animals, goats are slaughtered in large numbers in weekly or biweekly village markets and meat shops all over India. Even a small room with facilities for hanging the carcass, hygienic dressings, and washing away the soils is often not available. Besides the modern abattoirs in the large cities, a chain of standard slaughter units with adequate facilities should be created at the village level. Slaughter of animals should only be permitted by law and only be done in the proper location. Meat inspection must be rigid and compulsory, and involve microbial evaluation. Appropriate regions of the country should be maintained as a zone free of communicable diseases. The export of live animals should also be discouraged. Required trade criteria should be used in the slaughter procedure. Meat factories with stringent quality controls should be established for processing and packaging goat meat for export.

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Goat meat production in Indonesia

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Abstract: *Indonesia has the largest goat population among the countries of Southeast Asia. The two most important breeds are Kacang and Etawah. Goats are primarily raised for meat production on small farms. The contribution of goat meat to the total meat supply of Indonesia is 6–7%, with over 4 million goats slaughtered per year. There is a ready market for live goats and their transport is relatively easy. The marketing of fresh meat in open markets could be improved to increase the demand for meat. The development of a management system aimed at semicommercial operation would increase goat meat production.*

Résumé: *Le cheptel caprin de l'Indonésie est le plus important des pays d'Asie du Sud-Est. Les deux grandes races y sont la Kacang et l'Etawah. Dans les petites fermes, on élève la chèvre surtout pour sa viande. La viande caprine représente en Indonésie de 6 à 7 % de la production totale de viande; on y fait l'abattage de plus de 4 millions de chèvres chaque année. Il y existe déjà un marché pour l'animal sur pieds et son transport est relativement facile. L'accroissement de l'offre de viande fraîche dans les marchés libres stimulerait la demande de viande. L'implantation d'un système de gestion axé sur les activités semi-commerciales devrait permettre d'augmenter la production de viande caprine.*

Resumen: *Indonesia tiene la mayor cantidad de cabras del Sudeste Asiático. Las dos razas más importantes son la Kacang y la Etawah. Las cabras se crían primordialmente para la producción de carne en pequeñas granjas. La contribución de la carne de cabra al suministro total de carne de Indonesia es de 6 a 7%, sacrificándose más de cuatro millones de cabras al año. Existe ya un mercado para cabras vivas y su transporte es relativamente fácil. La comercialización de carne en mercados abiertos podría majorar para aumentar la demanda de carne. El desarrollo de un sistema de administración dirigido a una operación semicomercial incrementaría la producción de carne de caprinos.*

Indonesia is an archipelago consisting of more than 13,000 islands, of which only around 3,000 are inhabited. The human population of Indonesia is greater than 160 million. The small ruminant population of Indonesia (7.9 million goats and 3.8 million sheep) has remained relatively constant over the last 10 years. The human and goat populations are concentrated in a few provinces of Java; however, Java accounts for only 6–7% of the total land area of Indonesia (Table 1).

The goat population is increasing at an annual rate of 2.9%; the human population is increasing by 2.3% every year (Direktorat Bina Program 1983). Goats contribute 6–7% to the total volume of meat produced in Indonesia and the present average per capita consumption of goat meat is 4.3 kg/year. This represents a daily protein consumption of less than 2 g and is low compared with other countries of Southeast Asia. There is a great demand for goat meat in Indonesia, and this demand will likely increase in the future.

Table 1. Distribution of human and goat populations in relation to land area in Indonesia.

Region or island	Land area (km^2)	Population (no./km^2)	
		Human	Goat[a]
Sumatra	473606	59	1.6 (758.2)
Java and Madura	132187	690	46.2 (6106.0)
Bali and Nusa Tenggara Islands	88488	96	3.9 (347.9)
Kalimantan	539460	12	0.1 (55.9)
Sulawesi	189216	55	1.6 (310.7)
Maluku and Irian Jaya	496486	5	0.2 (81.8)
Total	1919443	-	(7660.4)

Source: DBP (1983).
[a]Values in parentheses are the actual goat populations ($x10^3$).

Table 2. Production of the Kacang and Etawah-grade goats in Indonesia.

	Kacang		Etawah grade	
	Male	Female	Male	Female
Birth weight (kg)				
Single	2.3±0.1	2.0±0.1	3.9±0.2	3.3±0.1
Twins	2.1±0.2	1.7±0.1	3.5±0.1	3.1±0.2
Weaning weight (kg)				
Single	10.1±0.6	8.5±0.9	14.6±0.9	12.3±0.3
Twins	9.4±0.2	7.7±0.9	9.1±0.5	9.4±1.0
Mature weight (kg)	27.04±0.8	24.2±0.8	43.0±3.2	34.2±1.0
Litter size	1.29		1.30	
Litter sex ratio (male:female)	45:55		47:53	

Source: Setiadi et al. (1985).

Genetic resources and productivity

The major breeds of goats in Indonesia are the indigenous Kacang and Etawah. The Kacang goat is relatively small, but is recognized as a prolific breed. It has no uniformity of colour, but black and brown are its base colours. The Etawah goat is much larger than the Kacang (Table 2); it originated from crossings between local goats and Jamunapari, which was imported from India between 1918 and 1931 (Obst et al. 1980). Etawah is considered a good milk producer, but goat milk is rarely consumed by smallholders. There has been little selection aimed at improving milk yields because goats are primarily kept for meat production. Recently, the Saanen goat was introduced into central Java, but their numbers are insignificant.

Goats in Indonesia do not follow a seasonal reproductive pattern as do those in temperate regions. In village conditions, the average kidding interval is 12–15 months. Goats are well adapted to the present management and environmental conditions in Indonesia. The average annual production of village goats is about

one offspring weaned per doe with an average growth rate of 20–40 g/day (T.D. Chaniago, unpublished data). Kacang and Etawah have average litter sizes of 1.29 and 1.30, respectively (Table 2). Under experimental conditions goats can produce 3.5 kids/year and are capable of growth rates in excess of 100 g/day (Obst et al. 1980). Optimization of environmental conditions in traditional systems would be an appropriate means of improving goat production.

Goat-production system

The goat-production system in Indonesia is based on small farms with two to five goats per farm; there are only a few medium-size farms (100–300 goats) in Java. In the traditional system, goats scavenge in low-input conditions. They are kept primarily as a living savings account to provide emergency cash, fertilizer, and hides, and to participate in religious ceremonies. Most farmers are unable to provide the cash input necessary for improved feeding or management. In spite of this, goats effectively use the available roughage and agricultural by-products and landless farmers often tether their goats on communal grazing lands. Under continuous confinement, productivity is determined by the amount and quality of the feeds provided. Therefore, the ability of the farmer or the farmer's family to obtain feeds for the animals and their knowledge of feeding are essential factors (Fig. 1). Farmers do attempt to provide palatable, nutritious forage to their goats.

This traditional system of production has remained despite the many efforts for improvement, e.g., village extension and pilot projects involving farmers. Recently, there has been a trend to develop medium-sized fattening operations. As a consequence, a regular supply of animals, uniform in size and age, is in high demand.

Meat production and marketing

Goats are sold in village markets; however, farmers usually deal with "village collectors" rather than trade in the village market. Two reasons for this are the high cost of transportation and the risk of not selling the animals on market day.

Fig. 1. Confined system of goats in an Indonesian village.

Table 3. Annual meat production of goats in Indonesia from 1974 to 1984.

	1974-76	1982	1983	1984
No. slaughtered ($x10^3$)	3147	3700	3800	3800
Carcass weight (kg/animal)	10	10	10	10
Meat produced ($x10^3$ t)	31	37	38	38

Source: FAO (1984).

On average, only 45% of goats offered for sale at a market in West Java are sold on a given day. The preference for dealing with a "village collector" is presumably dictated by the immediate need for cash, which is provided in advance of the sale. When dealing with a "village collector," the price of the goat is negotiated; in the market, brokers or livestock traders fix prices.

Animals sold in the market usually go to other farmers, local butchers, or long-distance traders. The largest market for goats is in Jakarta. Unlike cattle, the export of live goats or goat meat is not common in Indonesia. This is an area that could be improved in the future.

The demand for goats in Indonesia is relatively stable throughout the year, except during Idul Adha, when demand and price increase dramatically. In 1983, there were 897 slaughterhouses in Indonesia, of which 572 were public abattoirs (managed by local governments); the total slaughter capacity for goats and sheep was around 4000 head/day (DGLS 1984). The majority of goats are slaughtered in abattoirs. Goats can also legally be slaughtered in the farms and villages. Therefore, the number of goats reported slaughtered (Table 3) is far less than the actual number. The estimated meat production of goats has increased slightly from 1974 (Table 3).

The income elasticity of meat is greater than 1 (Anon. 1986), indicating that the demand for goat meat will increase as the living standards of the people increase. Goat meat is sold in open markets, meat shops, and through restaurants and supermarkets. Restaurants and supermarkets provide better meat, particularly for middle- and high-income groups because of better hygiene and storage facilities. In general, the open market and meat shops lack adequate storage, water supply, and waste disposal facilities. It is necessary, therefore, that the meat be sold the same day; consequently, if demand is low, the price of meat is often reduced at the end of the day. Cooked meat is also sold by small vendors; goat meat is often sold as "sate kambing," an Indonesian delicacy available in restaurants and street stalls. The offal of goats is also in demand. Lungs, liver, intestines, kidneys, and scrotum are all utilized and may be more expensive than the meat.

Developing the goat industry of Indonesia

It is a national priority to develop small farms as efficient, profitable production systems. This involves the implementation of new technologies. Technology-transfer programs for small ruminants have been implemented in some Indonesian villages. These programs include the dissemination of research results, pilot projects with direct farmer-researcher participation, and improved extension. All of these projects are designed to improve production and generate income for the farmer. However, only limited progress has been achieved by these

strategies, as the farmers often return to their traditional management practices once the program is terminated. This occurs possibly because the introduced changes do not provide an attractive motivation for their adoption or because the strategy of a low-profile change was not suitable for these farmers.

Although it is impossible for goat farming to generate a daily cash income, it may still be feasible to generate a cash income that is regularly distributed throughout the year. A strategy exploiting the nonreproductive seasonality of Indonesian goats could convince farmers to improve prevailing production systems.

Constraints to development

The adoption of a new technology by farmers depends largely on their social and economic conditions. It also depends on factors such as the availability of feed, labour, and working capital. It should be recognized that because it is impossible to increase the size of the farm, large-scale operations are difficult. However, production could be intensified and regulated, providing a higher income for the farmers.

Strategy for development

A strategy for the improvement of goat meat production must aim for a unified approach based on the smallholder system. An appropriate strategy would supply marketable kids regularly throughout the year. This would supply a more uniform income level throughout the year. For such a strategy to be successful, a technological package covering aspects of nutrition, breeding, health, and economics must be provided.

This model of production could be used throughout Indonesia. It is foreseeable that the availability of animals of uniform age and size in the market would encourage intensive growing and fattening operations. This will require the close cooperation of smallholders and large entrepreneurs engaged in growing and fattening operations.

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Goat meat production in Malaysia

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Abstract: *Although about 35% of the working population of Malaysia is involved in agriculture, and self-sufficiency in pigs, poultry, and eggs has been achieved, the ruminant sector, and particularly goats, has been neglected. Goats are almost entirely raised by the rural community in small farms where subsistence production systems with mixed farming are practiced. Inbreeding depression, poor husbandry, and poor nutrition have resulted in low productivity. These factors, coupled with kid mortality and high slaughter rates have resulted in a steady decline in the goat population over the last few years. The major constraints to increased goat production are the meat preferences of the population, government policies, and competition from sheep. Other constraints are common to the ruminant sector. Increasing goat meat production in smallholdings is discussed; the aim is to increase the number of animals by improved husbandry and nutrition. Crossbred goats should only be introduced in farms receptive to new technology.*

Résumé: *Même si environ 35 % de la population active de la Malaisie s'adonne à l'agriculture et est autosuffisante dans la production de porc, de volaille et d'oeuf, les ruminants, et plus particulièrement la chèvre, y ont été négligés. L'élevage de cet animal est le fait, presque exclusivement, des petites fermes des collectivités rurales, où l'on pratique une économie de subsistance axée sur la polyculture. Le dépérissement des troupeaux dû aux accouplements entre consanguins de même que la mauvaise qualité de l'élevage et de la nutrition ont baissé la productivité. Ces facteurs, outre le taux de mortalité des chevreaux et le taux d'abattage élevé, sont responsables de la diminution constante du cheptel caprin ces dernières années. Les préférences alimentaires de la population, les politiques du gouvernement et la concurrence offerte par le mouton sont les principaux obstacles à l'augmentation de la production caprine. L'élevage de la chèvre fait face aussi à d'autres obstacles, communs à tout le secteur des ruminants. On étudie la possibilité d'augmenter la production de viande caprine par les petits cultivateurs; le but est d'accroître le cheptel par l'amélioration de l'élevage et de la nutrition. On ne devrait toutefois introduire les croisements de chèvres que dans les fermes ouvertes à la nouvelle technologie.*

Resumen: *Aun cuando cerca del 35% de la población laboral en Malasia se ocupa de la agricultura y se ha alacanzado allí el autoabastecimiento con respecto a cerdos aves y huevos, se ha relegado el sector de los rumiantes, particularmente los caprinos. Las cabras son criadas en su mayor parte por la comunidad rural en pequeñas granjas donde se ponen en práctica sistemas productivos de subsistencia con agricultura mixta. Una crisis endogámica, baja calidad en las crías y una pobre nutrición han traído como consecuencia una baja productividad. Estos factores, unidos a la mortalidad de cabritos y altos índices de sacrificio han creado un continuo descenso en el número de cabras durante los últimos años. Las principales limitaciones para un aumento en la producción de cabras son las preferencias que tiene la población acerca del tipo de carne, las políticas del gobierno y la competencia que representa la carne de obeja. Otras limitaciones son comunes al sector de los rumiantes. Se discute el incremento de la producción de la carne de cabra en pequeñas propiedades; el objectivo es el de aumentar el número de animales a través de técnicas de crianza y nutrición mejoradas. Las cabras cruzadas se deberían introducir solamente en granjas que sean receptoras de la nueva technología.*

Agriculture plays an important role in the socioeconomic development of Malaysia. It provides employment for about 35% of the working population

(Malaysia 1985) and accounts for about 60% of the foreign exchange earnings. National agriculture policies have, therefore, been directed to sustain exports, increase productivity for farmers, increase employment, and attain food self-sufficiency. Unlike other developing countries, only 20% of the working population involved in agriculture grows food crops; the remaining 80% is involved in the production of export crops.

The livestock sector of Malaysia has been less important to the economy and accounts for only 10% of the gross value of agriculture production and 3.3% of the gross domestic products. About 50% of the beef and 25% of the mutton requirements are produced locally. Of the total animal output, pork, poultry, and eggs account for 92% and the remaining 8% is provided by ruminants in the form of milk, beef, goat meat (chevon), mutton, hides, and skin (Devendra 1983).

The nonruminant sector is well developed and rapid modernization has resulted in efficient pig and poultry production systems. The development of the ruminant sector, however, is less impressive, with most animals being raised in small farms under poor management conditions. Cattle production has recently received greater attention with the importation of many animals such as Droughtmaster and Australian Commercial Cattle for beef production and the Friesan-Sahiwal for milk production.

The goat industry is a neglected sector. Goats are almost entirely raised on smallholdings under poor management systems. Government policies toward increasing goat production in the past have been of low priority and it is envisaged that the development of the goat industry will be slow compared with other livestock industries.

Goat industry

Goats are almost entirely raised in rural communities by smallholders (Fig. 1), landless peasants, and estate workers. A small-scale subsistence production system with mixed farming on 0.1–0.3 ha of land is characteristic throughout Malaysia. Herds are small, typically 1–11 head (Devendra 1966; Peters et al. 1981). Devendra (1983) reported that herd sizes in Perak were larger and ranged from 11 to 63 head. Generally, estate workers keep larger herds because of the greater grazing area, particularly under rubber and oil-palm plantations.

The Malaysian farmer's main concern is crop production; goat rearing is pursued without additional demand on labour or ancillary inputs (Devendra 1983). The animals are of generally poor genetic material and are subject to poor husbandry and nutrition. Goat rearing is considered a sideline business and, because of the small herd size, no effort is made to improve the quality of the herd.

In recent years, several institutions, like the Malaysian Agricultural Research and Development Institute (MARDI), have initiated goat-breeding programs in an effort to conserve and upgrade local breeds as well as to produce superior crossbreeds. These efforts, however, have produced no significant improvements. Almost all the goat meat produced comes from smallholdings, and this trend is likely to persist for many years.

Goats account for 25.6% of the total ruminant population (Table 1). The goat population has declined in Peninsular Malaysia from 312,100 in 1980 to 274,000 in 1985. Of the 274,000 goats, about 110,000 (40%) are indigenous (Katjang); the remaining 164,000 (60%) are various crossbreeds (Wahid 1986/87). Although

Fig. 1. Improved goat housing in a typical Malaysian smallholding.

Table 1. Ruminant livestock population in Malaysia for 1985.

Species	Number	Contribution (%)
Swamp buffalo	160803	15.1
Murrah buffalo	2556	0.2
Beef cattle	454428	42.6
Dairy cattle	98247	9.2
Goats	273586	25.6
Sheep	78305	7.3
Total	1067925	100.0

Source: Division of Veterinary Services, Ministry of Agriculture, Kuala Lumpur, Malaysia.

goats are generally widely distributed, the major concentrations are found in the north and on the west coast of Peninsular Malaysia. Of the total goat population, 89% is found in Peninsular Malaysia; the remaining 11% is distributed in east Malaysia (Devendra 1983). The annual growth rate of the goat population between 1950 and 1980 was 1.2% (Devendra 1983). Since 1980, the condition of the goat population has worsened. High kid mortality, inbreeding, low-quality animals, poor management, and inadequate nutrition have reduced the goat population by about 10% from 1979 to 1982 (Mukherjee 1983). It is estimated that a goat population of 600,000 is needed for the country to achieve 25% self-sufficiency by the year 1990. This value was estimated using an annual extraction rate of 12% (80,000 heads) (Wahid 1981).

Meat production

Goat contribution

The total goat meat production in 1985 was estimated at 350 t (Table 2). This estimate does not include the approximately 20,000 goats that were slaughtered

Table 2. Goat population and goat meat production in Peninsular Malaysia (1985).

State	Goat population ($x10^3$)	Known slaughter[a]	Meat production[b]
Perlis	8.49	449	3.91
Kedah	42.44	3061	26.63
Pulau Pinang	16.70	15271	132.86
Perak	34.17	8968	78.02
Selangor	14.60	3128	27.21
Negri Sembilan	31.16	1812	15.76
Melaka	21.21	1125	9.79
Johor	26.96	343	2.98
Pahang	13.15	1604	13.96
Terengganu	20.01	568	4.94
Kelatan	44.24	3900	33.93
Wilayah Persekutuan	0.46	-	-
Total	273.59	40229	349.98

[a]Unrecorded slaughter accounts for about 50% of known slaughter.
[b]Meat production = number of animals known slaughtered x average carcass weight (8.7 kg) (Mahendranathan and Leong 1974; Vidyadaran et al. 1984).

illegally. Local goat meat accounted for 60% of total production (valued at MYR 3.72 million) (in February 1988, 2.4 Malaysian ringgits [MYR] = 1 United States dollar [USD]). The contribution of goat meat relative to the meat of other ruminants like buffalo, ox, and sheep is low and estimated to be only 4.6% (Devendra 1983). The supply of goat meat is declining and, in 1985, it accounted for only 3.8% of all meats produced by ruminants.

Carcass yield and consumption

Live weight is a useful measurement for assessing growth; however, it does not accurately predict the amount of meat on the carcass (Vidyadaran et al. 1984). Dressing percentage, although considered to be more reliable, is also influenced by variables such as age, sex, diet, stress, amount of noncarcass parts, and method of dissection. This accounts for the wide ranges for dressing percentages reported in goats. The goat has a lower dressing percentage than ox or sheep. The average empty live weight, hot carcass weight, and dressing percentage of Katjang goats were found to be 20.8 kg, 8.2 kg, and 39.6%, respectively. Devendra (1981) reported higher values for Katjang goats under better management. Goats also have a high proportion of muscle and a low proportion of fat (Vidyadaran et al. 1984). The dressing percentages of different breeds of goat found in Peninsular Malaysia differ (Table 3). Vidyadaran et al. (1984) observed that the percentage of expensive muscle in goat was similar to that of ox. Goats have proportionately more muscles along the spinal cord and proximal thoracic limb, and less in the proximal pelvic limb (Table 4).

Performance of different breeds

Generally, crossbred Katjang goats achieved higher average daily gain (ADG) than purebred Katjang (Table 5). Substantial growth occurred between 0 and 3 months and, subsequently, there was much less growth. The preliminary studies of Mustapha and Kamal (1982) indicate that grazing is more favourable for growth than is a semi-intensive system.

Table 3. Dressing percentage of different breeds of goats in Malaysia.

Breed	Sex	Dressing %	Source
Katjang	Male	51.3	Devendra (1981)
	Female	39.6	Vidyadaran et al.(1984)
Saanen x Anglo-Nubian x local	Male	40.14	Wahid et al.(1985)
Anglo-Nubian x local	Male	39.75	Wahid et al. (1985)
Saanen x Jamunapari x local	Male	39.34	Wahid et al. (1985)
Jamunapari x local	Male	39.57	Wahid et al. (1985)
Local	Male	44.0	Noraida (1986)
Local x German Fawn (F_1)	Male	44.0	Noraida (1986)
F_1 male x local (BC_1)	Male	46.0	Noraida (1986)

Table 4. The muscle weight distribution (% of total weight) of kambing katjang does and *Bos taurus* heifers.

Muscle group	Heifers[a] (H)	Does[b] (D)	D - H	Index[c]
Proximal pelvic limb	31.5	27.06	-4.44	85.9
Distal pelvic limb	4.3	4.95	0.65	115.0
Around spinal column	12.1	14.80	0.65	122.3
Abdominal wall	11.5	11.69	0.19	101.7
Proximal thoracic limb	12.4	13.22	0.82	106.6
Distal thoracic limb	2.3	3.15	0.85	137.0
Thorax-thoracic limb	10.3	8.26	-2.04	80.2
Neck-thoracic limb	5.2	5.70	0.50	109.6
Neck-thorax	9.0	11.14	-2.14	124.0

[a]Mean total side muscle weight, 77.6 kg; N = 63 (Berg and Butterfield 1978).
[b]Mean total side muscle weight, 2.70 kg; N = 12.
[c]Goat value relative to cattle = 100.

Protein consumption

The daily per capita consumption of protein of the population in Malaysia is 49.9 g. The main source of protein is from vegetables (36 g), followed by animal sources (8.9 g) and fish (5 g) (Devendra 1973). Thus, unlike Western diets, the predominant protein source of the Malaysian diet is vegetables. It is likely that the daily intake of animal protein will increase in the diet of Malaysians, but it is doubtful that the animal protein intake will ever reach the levels of Western diets. The ruminant contribution of daily protein intake was only 12%, compared with the nonruminant contribution of 87% (Devendra 1983). Goat meat only contributed 0.3% to the protein intake of an individual and, therefore, does not constitute a major component of the diet of Malaysians.

Meat preferences

It is relevant to consider the meat preferences of the major communities in Malaysia. Fish, poultry, and eggs are consumed by all races and probably constitute the main source of animal protein. The demand for beef is mainly by the Malay community, which form the majority of the population. Pork is forbidden to the Malays, who embrace the Islamic religion. The Chinese, which constitute the second-largest group in Malaysia, prefer pork and seldom eat beef or mutton. The

Table 5. Performance of different breeds of goats in Malaysia.

Breed	Condition[a]	Average daily weight gain (g)	Source[b]
Katjang x Jamunapari	SI	51 (0-3) 16 (3-9)	Tuen, unpublished
Katjang x Jamunapari	SI	19 (>12)	Tuen and Dahan (1987)
Katjang x Jamunapari	SI	75 (0-3) 25 (3-9) 10 (9-15)	
Katjang x Jamunapari	GR	88 (0-3) 55 (3-9) 44 (9-15)	Mustapha and Kamal (1982)
Katjang (75% cross)	I	52-63 (3-9)	Abdul Rahman et al. (1987)
Katjang x Katjang	SI	54 (0-3)	Wahid, Kamal, et al. (1987)
Katjang x Saanen	SI	71 (0-3) 33 (3-12)	
Katjang x Anglo-Nubian	SI	69 (0-3) 37 (3-12)	
(Saanen x Katjang) x Katjang	SI	60 (0-3) 39 (3-12)	
(Anglo-Nubian x Katjang) x Katjang	SI	64 (0-3) 37 (3-12)	
Anglo-Nubian x Anglo-Nubian	SI	86 (0-3) 41 (3-10)	
British Alpine x British Alpine	SI	83 (0-3) 34 (3-12)	
Saanen x Saanen	SI	84 (0-3) 21 (3-12)	

[a]SI, semi-intensive; GR, grazing; I, intensive.
[b]Values in parentheses indicate the age range (months) to which the daily weight gain applies.

Indians, who form about 10% of the population, are traditionally vegetarians but eat some poultry and mutton. Malays also consume a certain amount of goat meat that is available as a result of the slaughter of goats for religious purposes.

It is, therefore, a paradox that, on the one hand, there appears to be no great preference for goat meat and, on the other hand, there is a shortage of goat meat. This situation has arisen as a result of a declining goat population coupled with an increasing human population. Recently, Devendra (1983) reported in a study in Perak that all races expressed a desire to consume more mutton. Nevertheless, it is our belief that fish, poultry, eggs, pork, and beef will continue to form the major animal protein source of the diet of the various communities in Malaysia. Two other factors may contribute to a lesser demand for goat meat in the future. One is the belief that the saturated fat of goat meat is a predisposing factor for heart diseases and the other is that, except for a few, there is no greater preference for goat meat to mutton by the younger generation. It is envisaged that people will increasingly consume mutton because of the price differential. Mutton now costs, on average, MYR 7.36/kg; goat meat costs MYR 10.56/kg. Therefore, it is imperative that policies formulated to increase meat production should take into account the cultural, religious, and social factors of the various communities of Malaysia.

Marketing patterns

The demand and supply of various types of meat largely depend on the religious customs of the various communities of Malaysia. Because goat meat is mainly consumed by Indians and Malays, the slaughtering and marketing are predominantly controlled by these two races. There is no efficient marketing system because production is on a small scale and is scattered throughout the country. Moreover, there is no processing industry and almost all goat meat is sold fresh in the market.

There are basically two types of meat marketing (Devendra 1983). First, the animals are sold directly to the purchaser in exchange for goods, produce or kind, or, sometimes, cash. This type of deal is usually carried out with a neighbour or friend, and, therefore, live weight and other factors are not considered. Second, the farmer sells the animal directly to a middleman. The animals are sold on a live-weight basis or on an appraisal of the live weight and the physical condition of the animal. This system of sale favours the middleman, with the farmer getting a much lower price. At the moment, there are no farmers' organizations to coordinate the marketing and sale of goat meat.

Meat inspection is carried out in the abattoirs. As a rule, meat for human consumption must be inspected; however, this rule is often violated. The middleman transports the animals by lorry to a yard where the animals may be held for a day or two before being sent to the abattoir. In some cases, the animals are kept for some time, during which better nutrition is provided. After slaughter, the chilled meat is collected from the abattoir and the meat is either immediately sold in the market or frozen for future use.

There is considerable demand for goat meat during festive and religious occasions. The demand is sporadic and individuals may approach the middleman or the farmer. The animal is slaughtered in the neighbourhood and the meat is shared among members of the family.

There is no organized marketing system to handle large-scale distribution of meat for local or export markets. Efficient packing and marketing systems must be created if goat meat production is to increase.

Limitations to increased production

There are several constraints to increasing goat production. It is necessary to identify these constraints because, unless concerted efforts are taken to overcome them, it may be difficult to achieve production targets.

Meat preferences

The present demand and shortage of goat meat has arisen because the goat population has not increased at the same rate as the human population. Goat meat is not the preferred meat of any community. Furthermore, the younger generation is less discriminating toward goat meat and mutton. The high cost of goat meat also acts as a deterrent. However, a certain demand for goat will always exist because of religious slaughter. It is our view that the demand for goat meat will not increase and that an in-depth study on the future demand for goat meat is necessary.

Government policies

Present government policies on ruminants are largely directed toward increasing beef, milk, and mutton production. Incentives for commercial goat farming are limited or nonexistent. Large-scale commercial goat farming is, therefore, unlikely. For the immediate future, the smallholder is destined to continue to play the role of the producer and supplier. This dependence on the small-scale farmer is likely to be a serious constraint to increasing goat production, mainly because herd sizes are small and goat rearing is only considered a sideline enterprise. Farmers also have little knowledge of basic animal husbandry. The implementation of programs for improvement, therefore, will be difficult.

Competition from sheep

The sheep population of the country has been steadily increasing. They have adapted quite well to forage under rubber and oil palm plantations, causing little damage to the primary crop. The greater availability of cheaper mutton in the market will affect plans to increase goat production. The high price and inadequate preference for goat meat are also likely to affect goat production.

Suitability of breeds

The goats in smallholdings generally have poor genotype, inbreeding, poor nutrition, and other factors contributing to low weight gains. The Katjang breed is prolific and resistant to disease. Although crossbreeds (local × exotic) have better growth rates, their adaptability to small-farm conditions has not been evaluated. Rajendran and Pillai (1976) observed that although body weights of crossbreeds have improved over the years, the reproductive capacity was less than that of Katjang. Furthermore, the economics of production on smallholdings has not been studied. It must be determined whether rearing of crossbreeds is economical after additional inputs like better management and feeds are provided. The lack of information on economic goat rearing in rural areas is a serious constraint to increasing goat production.

Skilled labour

For economic goat production, farmers must acquire the knowledge and skills associated with goat husbandry. The younger generation are believed to be more innovative and to adapt better to new technology (Abidin 1984). In this context, the large migration of youths to urban areas is a matter of much concern. Unless this migration is checked, the task of increasing goat meat production will belong to the older generation, who are unlikely to face the challenges required for economic production.

High kid mortality

Various studies have shown that high kid mortality is an important constraint to increasing goat production. Kid losses range from 1.5 to 50% (Devendra 1962; Syed Mohna 1976; Lee et al. 1978; Mustapha and Kamal 1982; Diechert 1986). The problem with crossbreeds is even more serious. Little information is available regarding kid mortality among crossbreeds in smallholdings. Unless kid mortality is drastically reduced, the prospect of rapidly increasing goat populations remains dim.

Extension services

Present extension services are inadequate. Unless the smallholder has easy access to information and other services such as credit facilities, marketing outlets, etc., it is unlikely that the smallholder will make much progress.

Increasing goat production

The following factors must be considered to increase goat meat production:

- Government policies toward goat production,
- Dynamics of the rural population,
- Economic trends within the country,
- Meat produced for local or export markets, and
- Meat preferences of the population.

Once the overall objectives are identified, concerted efforts must be made toward identifying the production system that is most likely to succeed.

Small farms use production systems that utilize locally available resources. Often, these production systems are inefficient. Improvements are necessary to management, nutrition, and the reduction of the losses as a result of disease. It should be remembered that although technological advances like agronomy, veterinary, and genetic programs are available, the socioeconomic factor may be more complex and difficult to implement (Guss 1983).

Smallholdings

Commercial goat farming is unlikely to succeed because of scarcity of available land, uncertainties about the most appropriate production system, and low economic returns. Smallholdings are, therefore, likely to continue to be the main base for goat production. To increase production, the first step is to identify farms suitable for implementing the management program. Small farms can be categorized into three groups:

- Existing farms where there is little likelihood of improvement (group 1),
- Farms where some improvement can be achieved (group 2), and
- Farms receptive to new technology (group 3).

The overall plan should include factors like number of farms that are likely to be involved in the program, the number of farms involved in the 1st year and succeeding years, and the output after about 5 years.

The primary aim of the program should be to increase goat production through better management, nutrition, and decreased losses as a result of disease. The emphasis is on increasing goat numbers rather than on increasing body weight gains. It is unlikely that the farmer will immediately replace indigenous Katjang goats with improved crossbred goats. This is unlikely to occur in farm groups 1 and 2 because of the extra demand on labour and skill. Several reports of crossbred animals under various management conditions suggesting better performance than Katjang goats for birth weights, weaning weights, and live weights (Lee et al. 1978; Khushary et al. 1980; Wahid 1986/87; Wahid, Jemalos et al.

1987); however, little is known about the performance of crossbreeds on smallholdings. Indigenous animals that have evolved under poor nutritional environments have a lower nutrient requirement and, therefore, are less sensitive to changes in nutrient supply (Fricsh and Vercoe 1977). In contrast, genetically improved breeds are more responsive to nutritional inadequacy or stress. An evaluation of the feed resources of the farm is important so that there is no need for purchased feeds.

In farm group 3, the use of improved breeds, improved husbandry, and improved nutrition can be attempted. Ancillary services should be provided to support intensification.

Marketing

Marketing of farm products is a major problem in the developing world. The farmer is often unable to cope with surplus animals. Effective marketing systems including cooperatives and an assured stable price are essential.

Extension services

A comprehensive extension service providing multidisciplinary support is essential for the success of the goat meat production program. The services provided should include agriculture, veterinary medicine, and marketing training programs as well as credit facilities.

Research

Continuing research on all aspects of goat production, with particular emphasis on small farms is a prerequisite for improved goat meat production. In this respect, research into survivability, reproduction, and the economics of rearing crossbreeds on smallholdings are urgently needed.

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Goat meat production in Nepal

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Abstract: *Goat meat is consumed by all the communities of Nepal and is constantly in high demand. With a price rise of about 300% over the last decade, goat meat production has become an important means of income generation. The possibilities of expanding goat meat exports to India and goat skin exports to overseas markets further emphasizes the importance of goat production. A lack of marketing facilities (storage, slaughterhouses, and distribution systems), however, retards goat meat production. Additionally, inadequate scientific research on breeding, feeding, management, and disease control contribute to the low production. A technology package on goat meat production, including economic aspects of production, is urgently needed. National and international concern is required to strengthen national programs.*

Résumé: *Il se consomme de la viande caprine dans toutes les collectivités du Népal; la demande est élevée et constante. La hausse de prix d'environ 300 % qu'a connu la viande caprine au cours de la dernière décennie a fait de cette production une source importante de revenus. Les possibilités d'exporter plus de viande caprine vers Inde et de peaux de chèvres vers les marchés étrangers ajoutent de l'importance à la production caprine. Le manque d'installations commerciales (entrepôts, abattoirs et réseaux de distribution) retarde toutefois cette production. De plus, les lacunes dans les domaines de la recherche scientifique en élevage, de l'alimentation, des soins et de la lutte contre les maladies contribuent à la faiblesse de la production. La publication d'une série de documents techniques sur la production de viande caprine et ses aspects économiques est urgente. Le renforcement des programmes nationaux dépend de l'intérêt qu'on portera à ces questions à l'échelle nationale et internationale.*

Resumen: *La carne de cabra se consume por todas las comunidades de Nepal y tiene constantemente una gran demanda. Con un alza de precios de aproximadamente 300% durante la última década, la producción de carne de cabra se ha convertido en un importante medio de generación de ingresos. Las posibilidades de expandir las exportaciones de carne de cabra hacia la India y las de pieles de cabra hacia mercados extranjeros allende el océano, subrayan aun más la importancia de la producción de cabras. Sin embargo, la falta de instalaciones de comercialización (almacenes, mataderos y sistemas de distribución), retarda la producción de carne de cabra. Además, una investigación inadecuada sobre crianza, alimentación, explotación y control de enfermedades contribuye a una baja producción. Se necesita urgentemente un conjunto de medidas technológicas sobre la producción de carne de cabra, incluyendo aspectos económicos de la producción. Se necesita la atención nacional e internacional para fortalecer los programas nacionales.*

Goats are raised by Nepalese farmers for meat, income, and religious purposes. They account for the highest population among meat-producing animals (20%). The goat meat supply is about 10 times that of mutton, 5 times that of poultry, and 3 times that of pig meat. Because goats are raised for both family consumption and income generation, there is a growing interest in their production.

The price of goat meat has increased over 300% in the last 10 years. In addition, hides and manure, the by-products of goats, have economic value. The 30% increase in the goat population over the past 20 years is an indication of the farmers' positive attitude toward this species. The demand for goat meat in Nepal

is high, resulting in over 70,000 animals being imported from India and China every year.

Distribution of goats in Nepal

Recent livestock statistics from the Department of Food and Agriculture Marketing Service, His Majesty's Government of Nepal, indicate that there are 4.9 million goats in Nepal (DFAMS 1985). The goat population is highest in the central development region (1.5 million) followed by the eastern development region (1.4 million) (Fig. 1). These two eastern regions possess about 60% of the total goat population but account for only 38.1% of the land area of Nepal.

West of the central development region, the goat population decreased (Fig. 1). The goat population density in eastern Nepal is 50.5 goats/km^2; in west Nepal, 22.5 goats/km^2. Proportional to the goat population, the goat meat production was higher in eastern Nepal (52%) than in western Nepal (48%). The goat population is closely associated with the human population (Fig. 1).

Breeds of goats

The moderate body size, slow growth rate, poor milk-producing ability, and high prolificacy are some characteristic features of Nepalese goats. There is wide

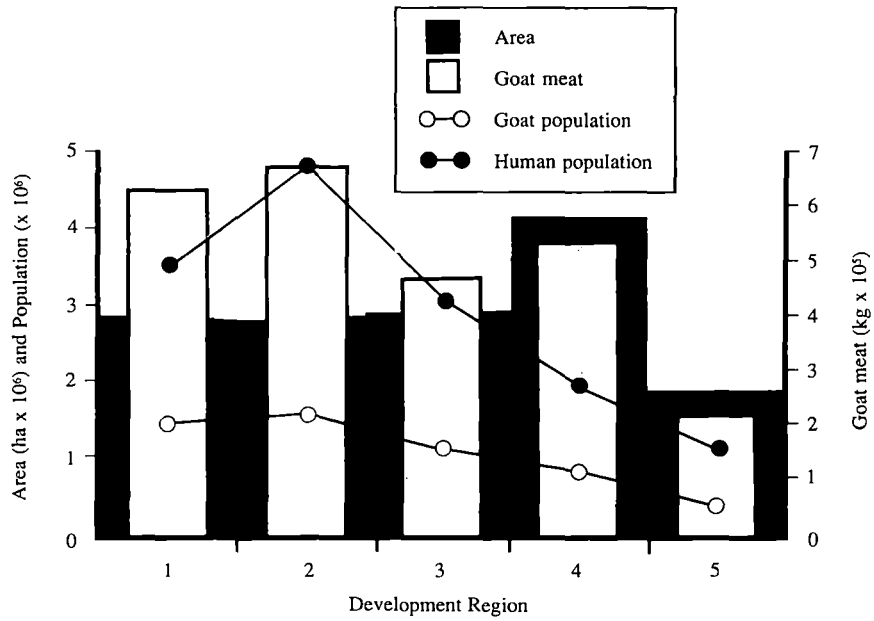

Fig. 1. Distribution of goats, humans, and goat meat production in different development regions of Nepal: 1, eastern; 2, central; 3, western; 4, midwestern; 5, far western. Development regions 1 and 2 make up east Nepal and development regions 3–5 make up west Nepal.

genetic diversity within local goat populations because of their adaptation to high altitudes, mid-hills, and terai and the influence of foreign breeds. The local breeds that are identified on the basis of topographical adaptation are Changra, Sinhal, Khari, and Terai. Among these four breeds, Khari (hill goats) is the main breed (56.2%) followed by Terai (27.2%), Sindhal (15.6%), and Changra (1%).

Khari has a moderate body size ranging from 27 to 40 kg. One of the prominent characteristics of this breed is its high prolificacy of 1.83 (Pradhan and Gurung 1985). Sinhal is commonly found in the wet, cold regions of the transitional zone in the high hills. Unlike the Khari breed, Sinhal is not as prolific, producing only 1 kid/year, and is marked by seasonal breeding behaviour. In a survey study of Sinhal goats, Karki (1984) found that 90% of kidding took place from October to March; the remaining 10% occurred from April to September. Most fertile conceptions occurred in the rainy, moderately cooler season (July to November), especially from September to November. Changra has long hair, curled horns, is found at high altitudes, and is mostly raised in transhumance systems along with sheep. This breed is useful as a pack animal and is famous for "pashmina" fur. Terai goats are characterized by a "Roman nose" and pendulous ears similar to the Jamunapari. Terai goats are also called "Lamkana" because of their pendulous ears. They are generally larger and produce more than other local breeds.

Feeding and management practices

The poor performance of the local goats is attributed to poor nutrition. In Janakpur, McTaggart and Wilkinson (1982) found that the growth rate of local goats was 100 g/day when they were fed berseem. When these goats were grazed in natural pasture, the growth rate dropped to 33 g/day.

Grazing in forest areas, tethering, or grazing in community pastures are common feeding practices in Nepal. The zero-grazing practice is not prevalent in the west part of Nepal, which has lower goat and human populations.

Smallholdings (0.2–0.3 ha) with small-scale goat production are characteristic of Nepal. Surveys in some districts of Nepal (e.g., Sharma 1982) gave an average of 0.41 goats/household. Homemakers and children take care of these goats.

Breeding and goat improvement

The genetic potential of local Khari goat is inferior to that of Jamunapari when growth rates are compared at two research stations (Table 1). To increase the production potential of local goats, His Majesty's Government of Nepal established a central goat improvement farm in Bandipur (in the mid-hills) by introducing Jamunapari from India in the 1970s. Saanen goats were also imported from Israel to improve local goats by cross-breeding for milk and meat production at Khumaltar in the Kathmandu valley, also in the early 1970s. The Jamunapari appears to have spread more widely than the Saanen, producing crossbreeds with lower prolificacy and poor growth rates (Table 2).

Jamunapari goats have been noted to frequently suffer in the mountain regions because of their susceptibility to disease and their poor adaptability (Karki 1984). Researchers in Nepal now must determine which breed(s) can contribute significantly to the economic well-being of the country. The problems in

Table 1. Goat population and goat meat production in Peninsular Malaysia (1985).

Study	Breed	Location[a]	Adult body weight (kg)	Age (weeks)	Growth rate (g/day)
Oli and Morel (1985)	Khari	PAC	-	15	50
	Jamunapari	PAC	-	15	50
Pradhan and Gurung (1985)	Khari	CGF	29	14	65
	Jamunapari	CGF	37	14	100

[a]PAC, Pakhribas Agricultural Centre, Shankuta, Nepal; CGF, Central Goat Farm, Bandipur, Nepal.

Table 2. Performance of local and Jamunapari x local goats at different locations in Nepal.

Characteristic	Local	Jamunapari x local	Source[a]
Adult body weight (kg)			
Bandipur	40.3 (35)	44.4 (22)	1
IAAS[b]	27.5 (25)	-	2
Live weight at 6 months (kg)			
Bandipur	13.3 (5)	16.1 (17)	1
Pakhribas	11.1 (23)	13.4 (9)	3
Growth rate (g/day)			
Bandipur	66.0 (5)	79.0 (36)	4
Pakhribas	51.0 (73)	55.0 (13)	3
IAAS[b]	45.0 (6)	-	5
Litter size			
Bandipur	1.83	1.27	4
Pakhribas	1.68	1.45	3
Age at first kidding (days)			
Bandipur	345	399	4
Pakhribas	460	630	3
Milk yield (L/lactation)			
Pakhribas	34.0	56.0	6
IAAS[b]	28.0	-	5
Khumaltar			
Hill goat	58.6	-	7
Terai goat	87.1	-	7

Note: Values in parentheses indicate the number of head observed.
[a]1, Singh (1984); 2, M. Kharel (personal observation); 3, Oli, 1987; 4, Pradhan and Gurung (1985); 5, Dhakal et al. (1985); 6, Oli and Morel (1985); 7, Pradhan (1979).
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goat improvement have arisen from faulty breeding practices and a lack of well-planned breeding programs. Poor breeding practices followed by farmers have been defined as "negative breeding" (Shrestha 1984). Usually, the best kids are castrated and later killed by butchers for meat. This reduces the number of breeding animals. The Department of Livestock Development and Animal Health has distributed about 250 locally selected bucks, mainly Jamunapari goats, to improve the quality of animals.

Some new problems

Some of the social changes in Nepal like family planning, new educational awareness, urbanization, new eating patterns, prohibition of meat by religion, etc., have contributed to changing livestock-raising practices. For example, family size has been reduced because of increased family planning and the labour of housewives and children, which was mainly responsible for the care of goats, has been decreased.

Moreover, because of people's educational awareness, they are sending their children to school, contributing to the reduced family labour strength. In addition, urbanization and industrialization have attracted many villagers to the urban areas. This situation, therefore, calls for some changes in management practices, e.g., stall feeding, programs for specialized farming, etc. From a survey of eastern Nepal, Oli (1985) reported that farmers who were previously practicing traditional grazing were now converting to zero grazing. This study also found that 42, 15, 14, and 29% of farmers were practicing communal, scavenging, migratory, and stall-feeding systems, respectively.

Marketing

Goats are marketed in a similar way to buffaloes (Upadhyay 1972). The largest goat markets in Nepal are Lahan (Udaipur), Shakhuwa (Janakpur), Dubahi (Sunsari), and Sanischare (Jhapa). These markets are mostly located in the inner Terai and Terai belts. From these markets, the traders transport goats in flocks of 50–100 to Kathmandu, Chitwan, and Pokhara for sale (Fig. 2). It is estimated that 150 goats are slaughtered every day in Kathmandu. The wholesaler/traders or middlemen sell the goats either directly to the consumers or to butchers, who then sell dressed meat. Since there are no public slaughterhouses or

Fig. 2. The sale of goats in a Kathmandu market.

storage facilities, goat meat is always sold as red meat. Goats are also transported across the border into India. Nepal, however, imports more goats from India than it exports (Table 3). About 4% of the imported goats come from Tibet, especially at festival time. Nepal, however, does not export goats to Tibet.

Pricing and trading

There is no authorized price-fixing agency in Nepal; trading is done between buyers and sellers based on the bargaining system. Because of the lack of weighing machines, the assessment of body weight is arbitrary and subjective, based on lifting the animal and on dentition. Butchers slaughter goats using a knife to remove the head. The dressed meat is sold in kilograms; however, an older system, the dharni (2.3 kg), is also widely used in the high hill and mountain districts although the metric system has been enforced in Nepal since 1968.

Consistent with the increasing demand for goat meat, there has been a continuous rise in the price (Fig. 3). The price increased 200% from 1977/78 to 1986/87. The price of goat meat also differs from one region of Nepal to another (Table 4). The prices in the eastern and central development zones are moderate. This is probably due to the higher number of goats per human, better marketing, and better transportation facilities. The price off goat meat is highly correlated with the human to goat ratio.

Over the last 10 years (1977–1987) prices have been higher from October to March than from April to September. This could be due to the people's preference to eat more meat in the winter than in the summer. Also, the important festivals, such as Durga Puja, occur after the summer, increasing the demand for goats.

Problems

One problem faced by the goat-raising industry of Nepal is the inadequate market and marketing facilities. Inaccessible, distant markets, poor marketing

Table 3. Export and import of goats ($x10^3$) in Nepal from 1981/82 to 1984/85.

	1981/82	1982/83	1983/84	1984/85
Export	63.5	56.3	38.2	61.3
Import	81.8	69.8	115.4	96.5

Source: Department of Customs, His Majesty's Government of Nepal, Kathmandu, Nepal.

Table 4. Average goat meat prices and human to goat ratios in the five development regions of Nepal.

Development region	Human to goat ratio	Price (NPR/kg)
Eastern	2.7:1	33.44
Central	3.3:1	38.58
Western	3.1:1	40.53
Midwestern	2.7:1	31.16
Far western	3.9:1	40.16

Source: DFAMS (1987).

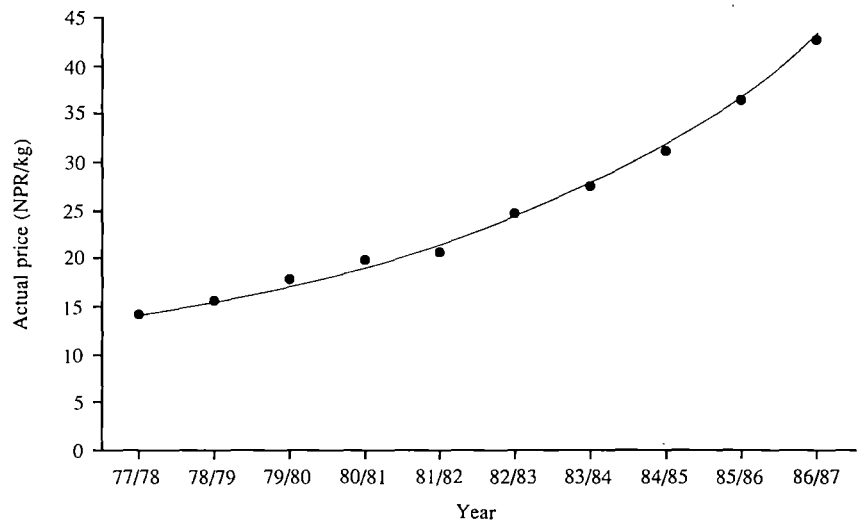

Fig. 3. Average price of goat meat during March–April from 1977 to 1987 (in February 1988, 21.1 Nepalese rupees [NPR] = 1 United States dollar [USD]).

facilities, and outlets only 1 or 2 days a week are real constraints to both consumers and producers.

The lack of slaughterhouses and storage houses is another problem. A network for the distribution of red meat is totally absent in Nepal. Slaughterhouses and storage facilities with credit and inspection facilities promote meat production (Rajbhandri 1984). There should be mechanisms to maintain excess goats away from the markets to regulate the supply of meat and control prices.

The goat industry of Nepal lacks a price-fixing agency. The lack of price control creates doubt and suspicion between primary producers and consumers. The proper pricing of goat meat is, thus, an effective means of regulating goat meat production.

Quality control is of concern to the consumer. Low-quality mutton from old ewes or aged goats is now sold as good-quality meat. Therefore, quality control and inspection of the dressed meat are essential to ensure that consumer preferences are met.

There is a lack of adequate credit facilities for goat farmers in Nepal. The same agencies provide loan facilities to farmers at minimum interest rates; however, goat production has not been included in their list of priorities.

The introduction of exotic breeds into Nepal has been problematic and haphazard. This is related to the absence of a proper breeding plan. There is also lack of fodder in terms of both quantity and quality. The production of good-quality fodder during the lean period (January–June) must be improved. This is one of the most serious constraints to goat production in Nepal.

Many farmers want a technology package for raising goats that deals with various aspects of production: feeding, breeding, housing, animal health, and economics. Poisonous plants and predators (tigers, leopards, and wolves) cause

considerable problems near the forest areas. Also major diseases have been noted in several reports on goat in Nepal (e.g., Morel 1985; Karki 1984). These diseases include liver fluke, internal parasites (e.g., tapeworms and roundworms), foot-and-mouth disease and foot rot, external parasites (e.g., mange, lice, and ticks), pneumonia, and brucellosis.

Prospects

The demand for goat meat in Nepal is high as it is accepted by all people; however, the supply cannot meet the demand. Therefore, goats are imported from Tibet and India, especially at festival time. The demand for goat meat is also high around the border areas of India. Goats are now exported to India and this market could be expanded by improving the goat-breeding program in Nepal. The price of castrated goat meat around the border area is NPR 50/kg in India; in Nepal, the price is NPR 45/kg.

Goat farmers earn more money than farmers in many other agricultural commodities. Realizing that goat production is a lucrative business, some richer people are showing interest in commercial goat production. Most of these investors are interested in starting with 50–100 goats.

Goats skins are another source of export earnings. They are exported to countries such as Italy, Japan, the United Kingdom, and the USSR. Export data from 1981/82 to 1986/87 show that export value increased from NPR 54.1×10^6 in 1981/82 to NPR 222.6×10^6 in 1985/86. The market declined to NPR 144.6×10^6 in 1986/87 because of competitive prices; however, the demand for goat skins is still high.

Artificial insemination of goat is not practiced in Nepal. Therefore, attempts to introduce superior goat breeds for cross-breeding have always been costly. Artificial insemination facilities must be developed to reduce the cost of purchasing exotic goats.

The goat population density in western Nepal is low. Increased efforts are necessary to stimulate production in this area. Although goats are reared for meat production, milk production must also be encouraged; people are already aware of the benefits of goat milk.

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Goat meat production in Pakistan

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Abstract: *This paper deals with the importance of goats, their utilization, and the development of meat production in Pakistan. Breeding, fattening, management practices, fertility rate, meat production potential, marketing, and slaughtering are discussed. Various factors hindering the development of the meat industry are also discussed. Recommendations are made for future research and developmental and organizational requirements for the improvement of the meat-production industry of Pakistan.*

Résumé: *Le présent document traite de l'importance de la chèvre, de son utilisation et de l'augmentation de la production de cette viande au Pakistan. Les questions qu'on y aborde sont : l'élevage, l'engraissage, la gestion des troupeaux, le taux de fertilité, les possibilités de production de viande caprine, la commercialisation et l'abattage, de même que les nombreux facteurs qui s'opposent à la croissance de cette industrie. Il renferme des recommandations sur l'avenir de l'industrie de production de viande au Pakistan : recherche, développement et structuration.*

Resumen: *Este trabajo trata sobre la importancia de las cabras, su utilización y el desarrollo de la producción de carne en Paquistán. Se discuten aquí las prácticas de crianza, engorde y explotación, el índice de fertilidad y el potencial de producción de carne, la comercialización y la matanza. Se discuten también varios factores que frenan el desarrollo de la industria de la carne. Se hacen recomendaciones sobre investigaciones futuras y requisitos de desarrollo y organizacionales para el mejoramiento de la industria productora de carne en Paquistán.*

Pakistan covers an area of 169.72×10^6 acres (1 acre = 0.405 ha). Of this total area, 24.5% (48.17×10^6 acres) is cultivatable land. There is also about 42×10^6 acres of rangelands, forests, etc. The country has subtropical, arid, and semi-arid regions. The vast tracts of rangeland in Pakistan, if properly developed, could support livestock.

The population of Pakistan, estimated at 92 million, is increasing at an annual rate of 3%, and is expected to surpass 136 million by the year 2000. With this population growth and improving living standards, the demand for meat is also increasing, and existing production systems are unlikely to meet this increasing demand.

The livestock species important for red meat production in Pakistan are cattle, buffaloes, sheep, and goats. Mutton and goat meat are by far the most expensive; beef is the cheapest. Goat meat is preferred over mutton in most parts of Pakistan. However, there are several constraints hampering the development of goat meat production.

It is estimated that 3.3 million households in Pakistan, mostly landless, own goats. Goats are mainly raised for meat production, although there are a few dairy breeds. Many goat breeds in Pakistan are dual purpose. Despite the importance of goats for meat production, no viable development or research program has thus far been implemented to stimulate increased production. This paper presents an overview of goat meat production in Pakistan.

Importance of goat meat

Agriculture contributes 34% to the countries gross domestic product (GDP), supports 75% of the population, and employs 52% of the total labour force. The livestock sector alone contributes about 28% to the total GDP in agriculture and generates 15.7% of total export earnings.

The goat population has increased from 22.4 million in 1976/77 to 30.8 million in 1985/86, growing at an annual rate of 3.8%, much more rapidly than the sheep and bovine stock (Table 1). This increase can be attributed to the increased demand for goat meat and, partly, to the popularity of small Bengal goats (Teddy). Goat husbandry plays a significant role, especially for small-scale farmers and landless families. The main contribution of goats is the supply of meat, milk, skins, and hair. Goat meat is more tender and leaner than mutton or beef. The price of goat and sheep meats are almost identical, but the majority of the population prefer goat meat. In certain areas (Peshawar, Quetta, and Kalat divisions), however, where cooking oil (butter oil) is scarce, mutton is preferred, as most sheep have fatty tails that are useful for cooking in place of butter oil.

Breeds and breeding

Goats in Pakistan have not yet been systematically studied. There are two types of goats: milk and meat producers. Twenty-five goat breeds have been described in Pakistan (Wahid 1975; Haider 1982; Khan et al. 1982; Alvi 1984; Hasnain 1985). Of these, Beetal, Dera Din Panah, and Kamori are considered good milch goats; Bikaneri, Chappar, Damani, Gaddi, Kaghani, and Kajli are well-known meat breeds. A small-sized breed, Teddy, has gained wide distribution and popularity over the last 20 years; it has a high prolificacy. Although a milch breed, Beetal is preferred over meat breeds because of its size, milk, and meat potential. Beetal not only produces a large quantity of meat but the meat is also preferred by consumers. Milch-type breeds are found in irrigated areas or around urban centres, where adequate fodder or grazing is available. Meat-type breeds are usually found in the "barani" or rain-fed areas where nutrition is deficient. In these areas, goats are grazed with sheep on ranges and are constantly on the move in search of grazing and browsing. Performance varies among breeds; light adult breeds average 20 kg; heavy breeds may reach 70 kg.

Table 1. Livestock population ($x10^6$) of Pakistan.

Year	Cattle	Buffalo	Sheep	Goats	Poultry
1976/77	15.0	10.9	19.5	22.4	48.6
1977/78	15.2	11.1	20.1	23.2	52.7
1978/79	15.4	11.3	20.7	24.0	57.4
1979/80	15.6	11.6	21.4	24.9	62.6
1980/81	15.8	11.9	22.1	25.8	67.4
1981/82	15.9	12.1	22.8	26.7	73.5
1982/83	16.1	12.4	23.5	27.7	89.5
1983/84	16.3	12.7	24.2	28.7	100.6
1984/85	16.5	13.4	25.0	29.7	113.7
1985/86	16.7	13.4	25.8	30.8	128.7
% change	11.3	22.9	32.3	37.5	164.8

Source: Pakistan (1986).

Breeding is haphazard and poorly organized. Bucks are usually left in the flocks all the time, resulting in year-round kidding. There are, however, peaks of breeding activity in the autumn and the spring. Male progeny, if not selected for breeding, are generally disposed of for slaughter at 6 months to 1 year of age.

Goat production practices

Of the 3.3 million households in Pakistan that own goats, 78.6% (2.6 million) own up to 5 goats, 20.1% (0.6 million) own more than 5 but less than 50 goats, and 1.3% (0.1 million) own more than 50 goats. Of the adult goat population, 9.9% is male and 90.1% is female, kept mostly for breeding. Goats are reared either by the farmers as a subsidiary occupation or by the poor, landless people. They are usually grazed, scavenge on tree leaves, or are fed crop residues. Rarely are goats fed cultivated fodders, and only under special circumstances are concentrates (mainly oil seed cakes) supplied. Several flocks are usually grazed together, along with sheep, by a village shepherd, who is paid by each flock owner. A common payment is a share of 50% of the progeny of the grazed flocks. The flocks are usually grazed in shamlat (common village property), on roadsides, or on canal banks. The flocks are collected from the owners for grazing early in the morning and brought back to the villages late in the afternoon. Goat housing in Pakistan is primitive. It is limited to open corrals that have mud walls or, more commonly, thorny bushes to confine the flocks at night and protect them from predators.

Growth and fattening

Planned studies on the growth rate of goats have not been undertaken. However, some information can be derived from the live weight data on several breeds maintained at the state livestock farms. Beetal and Teddy show the highest and lowest growth rates, respectively. The imported Angora goat has a high growth rate (Table 2).

Fattening studies on goats have been reviewed by Muller (1986). Feed intake, effects of crude fibre content, crude protein content, digestible energy level, initial body weight, and comparative performance of sheep and goats were studied in 115 experiments. Wide variations were found in feed intake. Besides the effect of genotype, there were effects of other variables such as diet, roughage/concentrate ratio, level of digestible energy, body weight, body condition and temperature, and experimental period. There was a highly significant correlation between dry matter intake (DMI) and body weight gain. Using regression analysis, daily body weight gains of 75–176 g were predicted with DMIs of 0.95–2.20 kg. The

Table 2. Growth rate (g/day) of various goat breeds.

Breed	Buck	Doe
Beetal	264	230
Hairy	207	169
Nachi	135	136
Dera Din Panah	135	132
Teddy	80	77
Angora	260	208

Source: Hasnain (1985).

crude fibre content was significantly correlated to live weight gain and feed efficiency. Both body weight gain and feed efficiency improved with decreases in crude fibre content. The daily weight gain was 86 g and the feed efficiency was 7.3 when crude fibre content was 35%. With a crude fibre content of 10%, the daily body weight gain increased to 167 g and the feed efficiency dropped to 6.3.

Fertility rate

The breed with the highest fertility percentage is Teddy (Table 3). The twinning percentage was lowest in Dera Din Panah and highest in Teddy goats. High prolificacy is the main feature of the Teddy and this is perhaps the major factor favouring an increased goat population in Pakistan. Experiments conducted at Bahadurnagar (Shah et al. 1979) indicated that Teddy goats were superior in breeding behaviour and meat-production potential than other breeds.

Meat production

There has been a steady increase in meat production from 1976/77 to 1985/86 (Table 4). Goat meat has consistently contributed 25% to the total meat production. At present, kids are slaughtered at low, lean body weights. Fattening of these animals for 100–200 days could add 5–6 kg to the carcass weight and improve the quality of the meat.

Table 3. Fertility and twinning percentage in goats.

Breed	Fertility (%)	Twinning (%)
Beetal	84	15
Nachi	75	26
Dera Din Pannah	66	10
Teddy	89	49
Hairy	81	36

Source: DLF (1962-82).

Table 4. Meat production ($x10^3$ t) from different species of livestock.

Year	Beef	Mutton	Goat meat	Poultry	Total
1976/77	375(53.0)	130(18.4)	173(24.4)	30(4.2)	708
1977/78	389(52.4)	137(18.4)	182(24.5)	35(4.2)	743
1978/79	404(51.8)	144(18.5)	191(24.5)	41(5.3)	780
1979/80	418(51.2)	151(18.5)	201(24.6)	47(5.8)	817
1980/81	434(50.5)	158(18.4)	212(24.7)	55(6.4)	859
1981/82	448(49.7)	166(18.4)	223(24.7)	65(7.2)	902
1982/83	465(49.2)	174(18.4)	234(24.7)	25(7.9)	947
1983/84	488(48.3)	186(18.4)	250(24.8)	86(8.5)	1010
1984/85	513(47.5)	198(18.4)	269(24.9)	99(9.2)	1079
1985/86	539(46.7)	211(18.3)	289(25.0)	114(9.9)	1154
% change	43.7	62.3	67.1	280.0	-

Note: Values in parentheses are meat production as a percentage of total production.
Source: Pakistan (1986); M.A. Khan (personal observation).

Marketing

Livestock marketing in Pakistan takes place in thousands of regular markets that are mostly organized by local bodies (e.g., district councils) once a week on fixed days. The Agricultural Produce Act of 1939 and subsequent legislation provide for the establishment and supervision of primary markets for farm products. However, livestock is not covered by the regulations. Livestock markets, therefore, are poorly equipped, loosely controlled, and operated in primitive ways. Animals are transported to the markets mostly by foot, by rail, or by road. Specialized transport vehicles are not used. A truck normally carries 60–80 sheep and goats. During transportation the animals may suffer weight loss, bruising, and even suffocation resulting in death.

The producer usually takes the animals to the local market, or to the town or city markets. However, the bulk of the animals are sold to itinerant traders (Pankaris in the Punjab). In large city and town markets in most parts of Pakistan, the commission agents (Arhtis) also operate (Fig. 1). In Lahore, there is another group of wholesalers, called Rewaitees, who deal in dressed carcasses (Fig. 1). They buy many goats and sheep from the Beoparies, through the Arhtis, get them slaughtered, and sell the dressed carcasses to the retailers. In Baluchistan, there are no Arhtis; the wholesalers gather animals in large markets, like Quetta, and then transport them to major consuming areas, like Karachi. The entire marketing of livestock as well as carcasses is on a unit basis graded subjectively. The total marketing cost between producers and consumers amounts to about 15% of the cost of the animal. The profit made by intermediaries is around 53%: the maximum profit was made by the retailer (19.6%) and the minimum by Arhtis (3.1%); the Pankari, the Beopari, and the Rewaitee, earn 6.6, 10.8, and 12.5% of the cost of the animal, respectively (PLD 1978).

Mutton, goat meat and beef are sold fresh and unchilled in small shops. All meats are sold during the same day; little, if any, is carried over to the following day. The retail price of meat is controlled in the cities and towns.

Prices and meat-pricing system

The type of meat, its quality, the selected cuts and joints, as well as demand and supply are the major factors affecting the price of meat. Although meat prices are still low by international standards, there has been a sharp increase over the last few years. In 1976/77, the retail price of goat meat and mutton was PKR 13.59/kg; that of beef, PKR 6.69/kg. In 1985/86, the official retail prices for goat meat and mutton and for beef were PKR 30.17 and PKR 14.01/kg, respectively (Pakistan 1986). This upward trend in prices continues despite measures taken by the government. In general, prices are higher in the cities than in rural areas.

Slaughterhouses

The slaughter facilities in Pakistan are mostly obsolete, unsanitary, and poorly managed, causing wastage of by-products. There are 292 recognized slaughterhouses, which have the capacity to slaughter 43,200 large and 22,000 small animals. Most slaughterhouses are in the Punjab (Table 5).

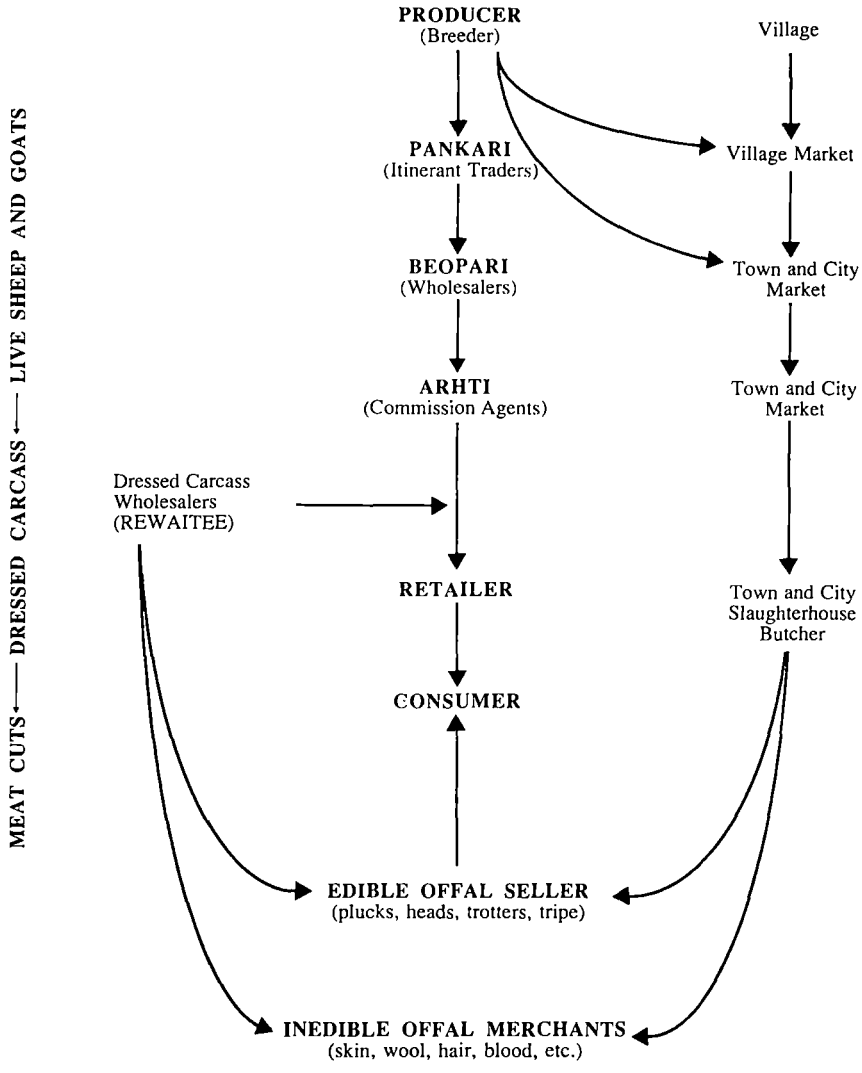

Fig. 1. Marketing channels of sheep and goats in Pakistan (Hasnain 1985).

There are two slaughterhouses, one in Karachi and the other in Islamabad, that have modern facilities. The slaughterhouse in Karachi is not used at all and that in Islamabad is only partially used. All the other slaughterhouses are obsolete and lack the light, water, hoisting, chilling arrangements, and proper drainage facilities. A large portion of the by-products such as blood, glands, intestines, and bone are either totally wasted or poorly processed. The workers are poorly trained and do not use modern tools, resulting in a loss of meat as well as damage to the hides and skins. According to the Pakistan Slaughterhouse Act of 1983, the slaughter of animals outside recognized slaughterhouses is prohibited. However,

unofficial estimates put unauthorized slaughter to be as much as 4–5 times that in recognized slaughterhouses. In Pakistan, the slaughter of animals other than poultry is prohibited 2 days a week to conserve livestock.

Constraints to development of the meat industry

Although Pakistan has a large number of different categories of livestock, meat production is low. Meat production and technology is a seriously neglected field of research and development. The meat industry as a whole is still in a primitive stage of development. The constraints that hinder the production of quality meat and the development of the meat industry are as follows:

- Shortage of improved pastures and quality feed;
- Lack of effective veterinary cover for disease control at clinical and subclinical levels and poor standards of animal husbandry and management;
- Lack of economic incentives resulting in nonadoption of suitable technology;
- Transportation and marketing difficulties for livestock and meat;
- Absence of quality control and carcass-grading system, and existence of obsolete methods of carcass handling and meat merchandizing;
- Price control on meat that does not consider production costs and meat quality;
- Acute shortage of technical and trained labour at professional and subprofessional levels in different facets of the meat industry; and
- Lack of research on various aspects of meat production, processing, preservation, marketing, and utilization of slaughterhouse by-products.

These constraints are not insurmountable and can be removed by proper planning, research, and development. With the available resources and the presence of a large livestock population and some of the best tropical breeds, the potential for increasing the production of high-quality meat for local as well as foreign markets is great. The removal of existing constraints and the adoption of suitable technology could double or even triple the meat yield presently obtained by traditional methods.

Table 5. Number and capacity of recognized slaughterhouses in Pakistan.

Province	No.	Daily capacity	
		Large animals	Small animals
Punjab	170	2585	12375
Sind	57	1262	7266
Baluchistan	40	119	864
Northwest Frontier Province	25	354	772
Total	292	4320	21277

Source: Khan (1987).

Recommendations

It is recommended that the following research programs, as well as the developmental and organizational work, be initiated.

Research Areas

- Studies on meat-production potential and economic traits, such as growth rate, feed-conversion efficiency, carcass traits, and muscle characteristics of different breeds of goats should be performed to establish base-line data for the meat industry.
- A coordinated national breeding program for the improvement of goats and for the evolution of mutton breeds through selection or crossbreeding is necessary.
- Fundamental studies on meat production, biochemistry, and meat quality in relation to feeding and management practices should be done.
- Studies are required to determine the most economical age for slaughter of kids on different planes of nutrition.
- Studies on the development of a carcass-grading system for local market and for export should be performed.
- Studies on the influence of transport methods, distance and time involved in transit, as well as seasonal variations on the injuries to animals and losses in carcass yield and meat quality are necessary.
- Studies on the improvement of meat quality by the use of electrical stimulation should be performed.
- Studies should be done to develop hygienically improved slaughter, dressing, cutting, distribution, cleaning, and disinfection procedures in slaughterhouses and meat shops.
- Studies on the utilization of slaughterhouse by-products and wastes in a manner favourable to environment are required.
- Research on the housing of goats in different ecological zones of the country is necessary.

Developmental and organizational measures

- Improved pastures, improved rangelands, and the utilization of agroindustrial by-products for formulation of nutritionally balanced rations should be developed.
- Husbandry practices, housing, and disease and parasitic control measures must be improved.
- A livestock and meat marketing infrastructure must be developed.
- Existing and new slaughterhouses should have proper facilities for the processing of slaughterhouse by-products.
- A meat research institute, provincial meat-monitoring units, and a school for the proper training of butchers and meat technicians should be established.
- A course on meat sciences at the undergraduate level in agricultural universities should be introduced.
- Price controls should be rationalized based on the quality and grade of meat.

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Goat meat production in the Philippines

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Abstract: *Goats play an important role in Philippine agriculture. They provide secondary income to farmers with minimum investment. More than 99% of goats are raised in the backyard. This has been the trend for many years. Goats account for a mere 2.2% of the total livestock and poultry population. From 1976 to 1986, the annual per capita consumption of goat meat (chevon) ranged from 0.14 to 0.24 kg. Goats in the Philippines are normally marketed on a per head basis passing through a five-level distribution system involving the producer, barrio agents, wholesalers, retailers, and consumers. The price difference between the farm and consumer is 60–75%. The goat industry has good potential if the marketing and production problems are solved.*

Résumé: *La chèvre est un élément important de l'agriculture philippine. Avec de minimes investissements, les fermiers en retirent des revenus d'appoint. Aux Philippines, c'est derrière la maison que se fait l'élevage de 99 % des chèvres, une pratique qui existe depuis de nombreuses années. Les chèvres y représentent à peine 2,2 % de l'ensemble du bétail et de la volaille. De 1976 à 1986, la consommation annuelle per capita de viande caprine est passée de 0,14 à 0,24 kg. La commercialisation des chèvres y est habituellement individuelle et soumise à un réseau de distribution à cinq paliers : producteurs, agents de quartier, grossistes, détaillants et consommateurs. L'écart entre le prix qui est versé au fermier et celui qu'on demande au consommateur est de 60 à 75 %. L'industrie caprine offre de bonnes possibilités, pourvu que soient résolus les problèmes de commercialisation et de production.*

Resumen: *La cabras desempeñan un importante papel en la agricultura de Filipinas. Con un mínimo de inversión, estos animales proporcionan ingresos secundarios a los granjeros. Más del 99% de las cabras se crían en el solar de la casa. Esta ha sido la tendencia por muchos años. Las cabras constituyen solamente un 2,2% de las existencias totales de ganado y aves. De 1976 a 1986, el consumo anual per cápita de carne de cabra fue de 0,14 a 0,24 kg. Las cabras en Filipinas se comercializan normalmente por cabeza, pasando a través de un sistema de distribución de cinco niveles en el que participan el productor, los agentes de barrio, el mayorista, el comerciante minorista y los consumidores. La diferencia de precio entre la granja y el consumidor es de 60 a 75%. La industrialización de la cabra tiene un buen potencial si se resuelven los problemas de comercialización y producción.*

Philippine goats exhibit considerable variation in conformation, hair colour, size, and productivity. Nevertheless, they are important multipurpose animals producing meat, milk, and skins. They are small, have inquisitive feeding habits, limited subcutaneous fat, a large surface area relative to body weight, and a short generation interval. Traditionally, goats are not looked after, with no attention given to their feed, water, and shelter (Abilay 1983); they are allowed to graze freely throughout day. Raising goats in the backyard takes little working time, the income generated, however, is also minimal. The average mature weight is 18 to 20 kg. Many goats are tethered in subdivisions and farm lots. The goat has developed into a "handy" animal that thrives in areas that differ markedly in agroclimatic conditions and level of management. It has survived despite near total neglect and is now found throughout the country. Goats are commonly found tethered to forage on noneconomic vegetation or are let loose in vacant lots otherwise nonproductive for agriculture.

The production of goats in the Philippines is low. Based on the Bureau of Agricultural Economics survey (BAE 1987), there were about 2.2×10^6 goats in 1986 of which more than 2.1×10^6 were raised in the backyard and only about 29×10^3 were raised on a commercial scale. Goat raising forms an important and integral part of smallholder agriculture in the countryside. The majority of goats (99%) are raised by farmers or by backyard raisers solely to supplement household incomes. The ownership pattern and the number of goats raised is 2 or 3 head/family. There are few commercial goat farms; the largest has no more than 400 breeding animals both for meat and milk production (Abilay 1983).

Goat meat (chevon) remains a special-occasion meat, slaughtered and eaten during special occasions such as birthday parties, weddings, and drinking sprees. It is usually prepared as "kilawen," "caldereta," "papaitan," etc. It is normally preferred by individuals who have developed the taste for it. Goat meat is seldom used in recipes for day to day consumption. Occasionally, goat meat is utilized for the production of cured products.

Consumption patterns

The average annual per capita meat consumption reported by the marketing service of BAE for 1962–1971 was about 15.3 kg (Abilay 1983). The distribution was 71.3% for pork, 23% for poultry, 5.2% for carabeef, and about 0.5% goat meat. In a 1974–1976 survey, the consumption pattern for meat was 61.7% for pork, 16.1% for carabeef and beef, 11.3% for poultry, 11.4% for all other meats and less than 0.5% for goat meat. In 1985, the Bureau of Animal Industry (BAI) planning survey indicated that the consumption of meat was 54.25% pork, 30.14% poultry, 12.81% beef, and 2.82% mutton, goat meat, and lamb.

From 1973 to 1983, the consumption of goat ranged from 7,443 to 12,358 t/year (Table 1). Per capita consumption was almost the same from 1973 to 1976, declined from 1977 to 1979, rebounded from 1980 to 1982, and dropped again in 1983 (Table 1). This trend is consistent with traders' claims that consumption increased during the early 1970s because of the proliferation of goat specialty restaurants that provided alternative products whose unit cost was much lower than the traditional live goats. The leveling off in the mid-1970s suggests a saturation of

Table 1. Per capita consumption of goat meat (1973–1981).

Year	Meat consumed (t/year)	Per capita consumption (kg)
1973	9778	0.24
1974	9507	0.23
1975	9249	0.22
1976	9004	0.21
1977	6669	0.15
1978	7624	0.17
1979	7712	0.15
1980	11326	0.23
1981	11558	0.23
1982	12358	0.24
1983	7443	0.14

Source: Adapted from Taccad (1985).

the market. The drop in consumption during the latter part of the 1970s and in 1983 was probably due to the general price increases of all commodities.

Patterns of production

Systems of raising goats

Goat production in the Philippines can be classified into three categories: tethering, integration with cropping systems, and intensive production (Taccad 1985). In these three systems, there is no clear definition of the objectives of production: meat or milk.

Tethering is the most common system, practiced by over 90% of the farmers. Most of these are small-scale farmers with less than 2 ha of land. Quite often, goats form an adjunct but important component of the integrated crop-livestock pattern of agriculture. The average size of the herd managed by smallholders ranges from one to five head. This indicates that small herds are common and that goats are secondary in nature. Goats are raised for additional income and for slaughter during fiestas and other special occasions. For these purposes, goats require minimal management and attention. The animals are cared for by unpaid family farm labour and they occupy a very small housing space. They are often tethered below the house at night. The tethered animals are normally not given additional feeds aside from crop residues they can graze on.

The source of stock to start the herd is commonly from the "iwi" system, where a doe is borrowed from a neighbour. It is bred and taken care of. When the doe gives birth to its kids, the owner and the caretaker divide the kids equally. When enough starting stock is obtained, the doe is returned to the owner and may be given to other farmers in the locality.

Despite the minimal attention given to the goats under this system, the doe gives birth three times in 2 years (Taccad 1985). Twinning is common; triplets occasionally occur. The mortality rate before weaning is high, about 20%. This is because of poor feeding, leading to low milk production by the doe and a high incidence of respiratory diseases and gastrointestinal parasites (Sevilla 1988). Because of this method of raising, the goats have evolved small to cope with the environment. Native goats become hardy and resistant to pests and diseases (Taccad 1985).

Goat integration with cropping systems is usually done by raising them under coconuts and other perennial crops. The system is not widespread because many farmers discriminate against it. Goats tend to eat and disturb the trunks of perennial crops.

The intensive production system has three variations. Goats may be allowed to graze on cultivated pastures, be fully confined, or be semiconfined in stalls. Under these systems, more intensive husbandry practices are used. Goats are supplemented with concentrates, but the amount given varies from farm to farm. It is on these farms that breeding is also practiced. There were about 31 farms of this kind in 1982 (MAF 1983). In 1985, the total population of goats in the Philippines was 2,190,750, of which the intensive system accounted for only 31,520 (Table 2). Backyard production accounts for 98.6%, and this trend exists in all regions of the country (Table 2).

The goats raised in the Philippines are essentially the native breed. The

government has introduced some foreign breeds such as the Anglo-Nubian, Alpine, Saanen, Toggenburg, and Jamunapari. In the few commercial farms, some of these breeds are maintained in their pure state. However, the majority are maintained as crosses or used to upgrade the native goats. In backyard farms, knowingly or unknowingly, foreign blood has also been introduced. The performance of foreign breeds in the country in terms of milk and meat production is consistently lower than the recorded performance of the breeds in their country of origin. This has been attributed to climatic conditions and to the generally poor nutrition and management.

Importance of goats

In 1976, goats accounted for only 1.3% of the livestock and poultry population. This increased to 3.0% in 1986 at the expense of chicken, carabao, and cattle. The average growth rate of the goat population from 1977 to 1984 was 11.5%. The goat population from 1976 to 1986 indicates that this species has not been emphasized compared with chicken, carabao, and cattle. Meat production follows a similar trend as that of livestock population (Table 3). Pork accounts for the bulk of meat produced. This is followed by poultry, beef, carabeef, and lamb, mutton,

Table 2. Goat inventory in backyard and commercial farms by region (1985).

Region	Backyard	Commercial	Total
Ilocos	246360	2290	248650
Cagayan Valley	50300	3740	54040
Central Luzon	139490	4210	143700
Southern Tagalog	212130	4160	216290
Bicol	113990	4800	116790
Central Luzon	-	-	-
Western Visayas	640	1880	233520
Central Visayas	7850	670	308520
Eastern Visayas	53530	180	53530
Western Mindanao	170090	440	170530
Northern Mindanao	147790	1630	149410
Southern Mindanao	258700	5800	264506
Central Mindanao	227550	1720	229270
Philippines	2159230	31520	2190750

Source: Anon. (1987).

Table 3. Meat production (t) from recognized abattoirs.

Year	Beef	Pork	Mutton lamb, goat meat	Horse meat	Chickens, ducks	Others, carabeef
1979	42629	64019	24	551	94399	83902
1980	45327	195041	680	704	12080040	39679
1981	43361	233422	920	1713	28504	13675
1982	39433	222806	1261	1437	36105	18373
1983	58836	240440	1437	775	56455	19537
1984	45586	255024	775	228	48482	25398
1985	43654	200153	2042	126	107025	18498

and goat meat. Lamb, mutton, and goat meat production consistently increased from 24 t in 1979 to 2042 t in 1985. It is estimated that by the year 2000, mutton, lamb, and goat meat production will be about 4020 t. If this production target is attained, there would be a minimal increase in per capita consumption because the human population would have increased considerably.

Marketing aspects

Traditionally, the meat-distribution system is multilayered with many middlemen involved in the process. The most common is the five-level distribution system (Fig. 1). Recently, producers started profits, resulting in a three-level distribution system (Fig. 1). The retailers may be divided into public markets and supermarkets, wet markets, groceries, and institutional markets.

Over 90% of goat meat is marketed live. Traders buy live goats on a per head basis and sell directly to livestock market centres. Prices are usually determined by buyers in accordance with the appearance of the animal. Prices vary from region to region, from year to year, and from month to month (Tables 4 and 5). Purchasing is usually done near important consumer centres. Fresh goat meat is retailed to consumers in a few public and private markets. Market prices of breeding animals vary based on the breed, size, age, and body conformation.

Farm gate prices of live goats are commonly highest in Ilocos, Central Luzon, Cagayan Valley, and some parts of Mindanao. The people of these regions have developed a taste for goat meat. Farm gate prices are low in April, May, June, October, November, and December (Table 5) and heavy disposals are common during these months.

In 1980, farm gate prices ranged from PHP 3.51 to 7.45/kg live weight, with an average price of PHP 5.31/kg (in March 1988, 18.8 Philippine pesos [PHP] = 1 United States dollar [USD]). In Metro Manila, live goats were priced at PHP 6.63/kg; goat carcass cost PHP 14.50/kg. In 1981, the export market prices for goat carcasses in Saudi Arabia and Hong Kong were USD 1.65 and 1.61/kg, respec-

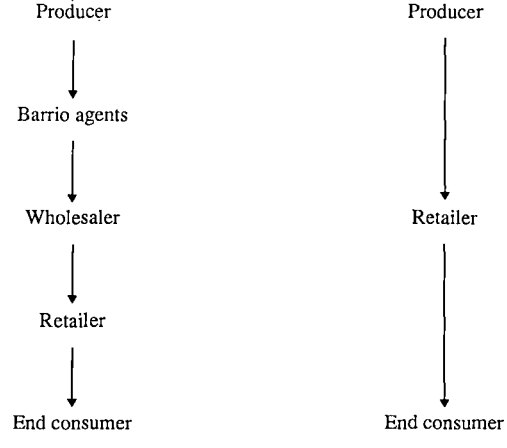

Fig. 1. Five- and three-level distribution systems.

Table 4. Average farm gate price (PHP/head live weight) of adult goats in selected regions (1971-1980).

Year	Philippines	Central Visayas	Ilocos
1971	30.9	25.32	43.43
1972	33.28 (7.5)	21.89 (-13.6)	44.69 (2.9)
1973	36.28 (10.6)	27.33 (24.8)	45.32 (3.6)
1974	53.80 (44.2)	38.75 (41.8)	66.50 (43.6)
1975	64.78 (22.0)	50.30 (29.8)	77.44 (16.4)
1976	74.81 (16.5)	63.36 (26.0)	90.75 (17.2)
1977	79.74 (6.6)	72.39 (14.2)	93.76 (3.3)
1978	77.68 (-2.6)	66.67 (-7.9)	93.29 (-0.1)
1979	91.91 (18.3)	61.90 (7.2)	120.06 (28.7)
1980	106.22 (15.6)	69.16 (11.7)	140.18 (16.8)
AAI[a]	16.3	16.6	16.2

Note: Values in parentheses represent the percent increase (or decrease) from the previous year. In March, 1988, 18.8 Philippine pesos (PHP) = 1 United States dollar (USD).
Source: Taccad (1985).
[a]Average annual increase.

Table 5. Seasonal index of prices (PHP) received by farmers for adult goats in selected areas (1971-1980).

Month	Philippines	Central Visayas	Ilocos
January	102.02	96.68	102.68
February	102.56	105.61	100.70
March	101.86	117.93	94.87
April	87.19	100.00	101.93
May	100.78	101.23	99.74
June	100.30	97.29	98.38
July	101.78	96.27	100.29
August	100.30	95.94	100.51
September	100.49	94.26	100.21
October	98.43	98.89	99.66
November	99.37	99.98	100.96
December	97.25	98.73	99.12

Note: In March, 1988, 18.8 Philippine pesos (PHP) = 1 United States dollar (USD).
Source: BAE (1987).

tively. This is equivalent to PHP 13/kg, which is 19% lower than the 1981 prevailing price of PHP 16/kg.

In 1978, the farm gate price in Southern Tagalog farms and the retail price at the Quezon City market differed by PHP 53.36/head (Table 6). This represents a 71% increase in price. Similar gaps between farm gate and retail outlet prices were observed in 1979 and 1980. In certain cases, roadside market vendors slaughtered an animal that has been selected by the buyer. The carcass is left intact for the buyer. Product quality control and standardization practices are virtually nonexistent.

The goat distribution system varies from direct selling to selling through several agents. There are many trading schemes, but the major interprovincial traders are the municipal middlemen. In 1980, BAI reported 17 market centres where these middlemen operate. The goats are either brought directly to these market centres by the raisers or they are collected from individual farms by barrio agents. These barrio agents either operate on their own or are commissioned by

Table 6. Average farm gate and outlet prices (PHP/head) of live goats (1978-1979).

Year	Farm gate price		Outlet price, quantity	
	Philippines	Southern Tagalog	Wholesale	Retail
1978	77.68	74.94	101.20	128.30
1979	91.91	88.87	117.20	154.83
1980	106.22	107.72	138.92	189.30

Note: In March, 1988, 18.8 Philippines pesos (PHP) = 1 United States dollar (USD).
Source: Taccad (1985).

the middlemen to do the purchasing. The middlemen, in turn, ship the animals to the retailers.

In Metro Manila, retailers are concentrated along Quezon Boulevard and 20th Avenue in Quezon City and along EDSA in Caloocan City. Most retailers have been selling goats for over 10 years. The main sources of goats sold in these markets are Batangas, Cebu, Iloilo, Masbate, Samar, and Negros provinces. Goats from the southern islands are usually delivered once a week; goats from Batangas and nearby areas are delivered twice a week.

There are three common problems in goat marketing. First, because there are too many trade channels, procurement costs are high; during the past 3 years, prices have increased several times. Second, competition for goats during the peak months is intense and, during off-peak months, there is an excess supply. Third, demand and supply are seasonal; the two do not normally coincide.

On average, wholesalers mark up prices almost 30% (Taccad 1985). Retailers earn about 32%. This means that the farmer gets only about 40% of the amount the consumer pays for the goat meat.

Problems of the industry

Abilay (1983) outlined the problems of the goat industry as follows:

- Low productivity of goats as a result of general neglect of the species; low-quality breeding stock, poor nutrition, poor management practices, poor health programs, and inadequate services contribute to low productivity;
- Inefficient marketing as a result of a lack of organized marketing schemes and market standards, inadequate market information, etc;
- Inadequate capital; and
- Lack of well-trained goat scientists.

The utilization scheme for goats is a traditional problem. Because goat meat is a "special occasion" meat, demand has always been erratic. Plenty of Filipinos still discriminate against it; this may be due to availability problems in market stalls. It is much easier to buy pork, beef, poultry or carabeef than to buy goat meat.

Goat is a favorite meat during festivals. Data is unavailable on the amount of goat meat consumed compared with that actually produced. Because of inade-

quate supplies, all the meat produced is consumed. Goat meat consumption has always been associated with extravagance.

According to BAE (1987), about 5% of the adult goat population and 20% of newborn kids die every year. This high mortality has been attributed to poor husbandry practices and parasitic infestations.

Recommendations

Increased production can be easily achieved if an enterprise is proven to have high profitability. There must be an educational campaign to fight discrimination against goat meat. With increased consumption and demand, increased supply has to follow. Goat meat has to be made available on a retail basis, i.e., not on a per head basis. It appears that one of the reasons goat meat is not popular is that one has to buy the whole goat. There are few markets selling goat by the kilogram.

The price difference between the farm gate and the consumers must be reduced. Present trading channels for goats add about 60–75% to the price of animals. Productivity is still low because of poor husbandry practices. If the retail price was lowered to about the price at the farm gate, goat meat would become more popular. If the retail price of goat meat is maintained at its present level and the price at the farm gate is increased to almost the retail price, then the goat industry would become a lucrative business. High productivity will, in turn, attract investors to a point where there will be an oversupply of goat meat. Because of competition, however, only the efficient, well-managed enterprises will thrive. This competition would encourage the improvement of goat rearing, with reference to better management, better breeding stock, and increased production.

There is also considerable opportunity to utilize goat meat for processed products. It has been proven to have high acceptability, especially when used in combination with other meats. By-products from slaughter can also be processed for commercial sale.

For the export market, in 1982, the top 20 importers together imported approximately 14×10^6 sheep and goats (FAO 1984). Saudi Arabia tops the list with 3.2×10^6 head followed by Iran, Italy, Kuwait, and Libya. The use of improved breeds to produce better quality meat implies that the Philippines can also have a share of the foreign market. There have been some attempts to export goat meat to Saudi Arabia in the past, but these attempts were limited by inadequate volume and quality standards for regular shipping.

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Goat meat production in Sri Lanka

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Abstract: *Sri Lanka has a goat population of about 534,000. The highest concentration of goats are found in the dry and dry intermediate zones. These agroecological zones have a lower population density, thus goats are reared in an extensive system for meat production. The majority of goats reared in Sri Lanka are local or indigenous goats and crosses with improved breeds such as Jamunapari, Beetal, and Boer. Local goats produce little milk and are reared mainly for meat. The annual per capita consumption of goat meat in Sri Lanka is about 0.09 kg. The national extraction rate of goats for meat is about 25%. However, illegal slaughter accounts for about 17%. Goat meat marketing is controlled by the private sector. The present farm gate price per kilogram live weight ranges from SLR 18 to 28 (in March 1988, 31 Sri Lankan rupees [SLR] = 1 United States dollar [USD]). The retail price of goat meat in urban areas is higher than in rural areas. Among the different types of meats marketed in the country, goat meat fetches the highest possible price. The quality of goat meat is poor because of a high bone to lean ratio. These two factors have caused lower consumer preference for goat meat. A lowering of production costs and improvement of carcass quality of goat meat have to be achieved to increase consumption. A sustained policy on goat development was initiated through the Sri Lanka – German Goat Development Programme in 1982. This program has created a considerable impact in the five districts selected for herd improvement, by the introduction of the Boer meat breed. If this program could also be introduced to the other districts by using such breeds as Jamunapari and Kotukachchiya (originated as a cross of Beetal and local goat) in addition to the Boer, Sri Lanka has a vast potential for developing the goat meat industry.*

Résumé: *Le cheptel caprin du Sri Lanka, environ 534 000 têtes, est surtout concentré dans les zones arides et les zones d'aridité moyenne. Ces écozones agricoles présentent une faible densité de population, de sorte que l'élevage de la chèvre se fait dans le cadre d'un vaste système de production de viande. La majorité des chèvres du Sri Lanka sont de race locale ou indigène, ou des croisements avec des races améliorées comme la Jamunapari, la Beetal et la Boer. Les chèvres locales produisent peu de lait et sont élevées surtout pour leur viande. La consommation annuelle sri lankaise de viande caprine est d'environ 0,09 kg par habitant. Le pourcentage des chèvres qui y sont élevées pour la viande est d'environ 25 % mais celui des abattages illégaux, d'environ 17 %. La commercialisation de cette viande est entre les mains du secteur privé. Le prix au kilogramme versé actuellement à la ferme pour l'animal sur pied se situe entre 18 et 28 SLR (en mars 1988 le change était de 31 roupies sri lankaise [SLR] contre un dollar américain [USD]). Le prix de détail de la viande caprine est plus élevé dans les zones urbaines que dans les zones rurales. De toutes les viandes commercialisées dans le pays, la viande caprine est la plus chère. Elle est cependant de mauvaise qualité car elle présente une grande quantité d'os par rapport à la viande maigre, deux facteurs qui expliquent pourquoi elle est peu recherchée par le consommateur. L'abaissement des coûts de production et l'amélioration de la qualité des carcasses de viande caprine sont les deux conditions de l'augmentation de sa consommation. Le programme germano-sri lankais d'exploitation caprine lancé en 1982 est à l'origine de la politique soutenue qui prévaut depuis en ce domaine. Ce programme a eu, grâce à l'introduction de la Boer, une race de boucherie, une portée considérable dans les cinq districts choisis pour améliorer les troupeaux. L'implantation de ce programme dans d'autres districts à l'aide de la Jamunapari et de la Kotukachchiya (un croisement de Beetal et de chèvres locales) en plus de la Boer ouvrirait de grandes possibilités à l'industrie de la viande caprine, au Sri Lanka.*

Resumen: *Sri Lanka tiene aproximademente 534.000 cabras. La más alta concentración de cabras se encuentra en las zonas secas y en las secas intermedias. Estas zonas agroecológicas tienen una baja densidad de población, por ello las cabras se crían en un sistema extensivo de producción de*

carne. La mayoría de las cabras criadas en Sri Lanka son cabras locales y nativas y cruzamientos con razas mejoradas como la Jamunapari, Beetal y Boer. Las cabras locales producen poca leche y se crían fundamentalmente para la producción de carne. El consumo anual per cápita de carne de cabra en Sri Lanka es cerca de 0,09 kg. La tara nacional de producción de cabras para la obtención de carne es de aproximadamente 25%. Sin embargo, la matanza ilegal alcanza 17%. La comercialización de la carne de cabra está controlada por el sector privado. El precio actual a la puerta de la granja por kg de peso vivo va de 18 a 28 SLR (marzo de 1988, 31 rupias de Sri Lanka [SLR] = 1 dólar norteamericano [USD]. El precio de venta de la carne de cabra en áreas urbanas es mayor que en las rurales. Entre los diferentes tipos de carnes que se comercializan en el páis, la carne de cabra se cendió al precio más alto. La calidad de la carne de cabra es pobre a causa de un elevado coeficiente en la relación hueso-carne magra. Estos dos factores han hecho que sea menor la preferencia de los consumidores por la carne de cabra. Para incrementar el consumo hay que disminuir los costos de producción y mejorar la calidad en la canal de la carne de cabra. En 1982, se inició una política permanente de desarrollo de cabras a través del Programa Sri Lanka – Alemania para el Desarrollo de Cabras . En los cinco distritos seleccionados para el mejoramiento de los rebaños, este programa ha ejercido un considerable efecto a través de la introducción de la raza Boer, productora de carne. Si este programa se pudiera introducir también en otros distritos utilizando tales razas como la Jamunapari y la Kotukachchiya (originadas de un cruce de Beetal y de cabra local) además de la Boer, Sri Lanka tendría un vasto potencial para desarrollar la industria de carne de cabra.

Sri Lanka has a goat population of about 534,000 (Table 1). These goats are distributed throughout the country; however, the highest concentration of goats are found in the dry and dry intermediate zones (Table 2). These two agro-ecological zones are drier than the other agroecological zones and, therefore, have a lower population density. This makes more land available for extensive goat production. The goats are reared in these regions mainly for meat production (Table 3). The majority of goats reared in Sri Lanka are local or indigenous goats and crosses with improved breeds (Table 4). The locally evolved breed, Kotukachchiya, originated from crossing local goats with Beetal goats imported from India.

A survey in eight representative districts of all agroecological zones revealed that 89.1% of goats were reared for meat alone; the remaining 10.9% were reared for milk or for both meat and milk (Table 3). Milk-producing goats are found around urban areas, where goat milk is sold for home consumption. Milk-producing goats are mostly crosses of Saanen, Jamunapari, and Anglo-Nubian with indigenous or local goats. The origin of the local breed is unknown. They produce only enough milk to satisfy the minimum requirement of their kids. The meat production potential of these goats is also low. The average carcass weight is 10–11 kg (Table 5).

Goat production systems

In the dry and dry intermediate zones, goats are reared under extensive or semi-intensive systems of management. Herd sizes maintained in these regions are larger than those in other agroecological zones (Table 6). The vast majority of farmers own land (Table 7) and goat herds are mainly browsed (Table 8). The goats are stall-fed at night during June, July, August, and September when fodder production is affected by continuous drought.

In the wet intermediate and wet zones, semi-intensive or intensive systems of management are practiced. The land available for browsing is limited in these agroecological zones and farmers maintain small herds on their own land (Tables 7 and 8). The fodder for stall feeding is mainly obtained from the farmer's land with supplementation from neighbouring properties (Table 8). Farmers who rear goats for milk production in these regions feed their herd cheap concentrates and kitchen refuse.

Table 1. Trends in population growth of goats, slaughter rates and per capita availability of goat meat from 1960 to 1986.

Year	Goat population ($x10^3$)	Goats slaughtered ($x10^3$)	Meat production (t)	Imports of goat meat (t)	Per capita availability (g/day)[b]
1960	491	124 (25.3)	1236.5	200	0.47
1961	492	125 (25.4)	1251.7	200	0.55
1962	454	124 (27.3)	1233.2	80	0.49
1963	538	121 (22.5)	1211.5	60	0.47
1964	567	129 (22.8)	1288.9	110	0.49
1965	600	140 (23.3)	1398.5	300	0.58
1966	590	139 (23.6)	1398.7	500	0.60
1967	580	161 (27.8)	1603.5	170	0.35
1968	584	146 (25.0)	1459.9	4	0.27
1969	543	126 (23.2)	1256.2	10	0.22
1970	558	131 (23.5)	1302.1	2	0.18
1971	546	123 (22.5)	1224.8	2	0.19
1972	548	114 (21.7)	1135.2	-	0.19
1973	549	125 (22.8)	1244.4	-	0.29
1974	547	138 (25.2)	1371.9	0.5	0.10
1975	547	141 (25.8)	1410.2	11	0.28
1976	562	133 (23.7)	1330.6	3	0.26
1977	545	128 (23.5)	1275.5	2	0.25
1978	450	127 (28.2)	1265.9	476	0.33
1979	461	124 (26.9)	1233.5	1	0.25
1980	493	137 (27.8)	1365.7	13	0.25
1981	512	137 (26.8)	1368.5	20	0.25
1982	512	163 (31.8)	1629.6	96	0.30
1983	519	135 (26.0)	1340.9	110	0.25
1984	535	151 (28.2)	1506.5	55	0.27
1985	540	144 (26.7)	1436.5	62	0.25
1986	534	121 (22.7)	1214.3	NA	NA

Note: NA, not available.
Source: MRID (1985)
[a] Values in parentheses represent the number of goats slaughtered as a percentage of goat population.
[b] Annual per capita consumption of goat meat (1984/85) = 95 g.

Present status of meat production

The per capita goat meat consumption in Sri Lanka is 0.09 kg/year or 0.25 g/day. These values are based on data obtained from registered slaughterhouses. However, it is known that there is a significant amount of illegal and unaccounted slaughter for festivals, functions, and sacrifices. The actual per capita availability is, therefore, higher than the reported data. Available data reveal illegal and unaccounted slaughter would add 17% to the reported 25% annual extraction rate registered in slaughterhouses. Also, Table 1 reveals that there has been an 88% decrease in per capita availability from 1960 to 1985. This decline is due to a reduction in the goat population because of a high extraction rate and an increase in unregistered slaughter. This unregistered slaughter is due to increases in the human population.

Of the total annual slaughter of goats, 68% occurs in the Colombo slaughterhouse. Colombo is apparently the main area of goat meat consumption in Sri Lanka.

Table 2. Distribution of the goat population by producing region.

Region	1981	1982	1983	1984	1985	1986
Coconut Triangle	100600	107000	107000	108777	115000	116
Tea Triangle	45800	43300	44800	47703	44800	49400
Mid country	41700	35300	40200	41050	40700	40100
Low country, Wet zone	23300	25400	25100	25082	23800	22200
Dry zone (north and east)	236600	2384000	52800	255759	251100	241600
Other areas	51800	62200	49400	57399	60200	64100
All regions	499800	511600	519300	535770	539600	533600

Source: Rajaguru and Senanayake (1987).

Table 3. Distribution of goats and farmers by district according to product.

District	Total	Meat	Milk	Meat and milk	Manure
Anuradhapura					
Goats	272	252	-	20	-
Farmers	18	17	-	1	15
Badulla					
Goats	144	97	26	21	-
Farmers	18	13	1	4	1
Hambantala					
Goats	1164	1142	-	219	-
Farmers	36	32	-	4	3
Kandy					
Goats	192	127	-	65	-
Farmers	28	16	-	12	2
Kegalla					
Goats	115	109	2	4	-
Farmers	14	12	1	1	-
Moneragala					
Goats	95	93	-	1	-
Farmers	5	4	-	1	-
Polonnaruwa					
Goats	264	254	-	10	-
Farmers	20	19	-	1	-
Puttalam					
Goats	206	206	-	-	-
Farmers	12	12	-	-	4
Average goats reared (%)		89.1	2.7	8.2	8.4

Source: Rajaguru and Senanayake (1987).

Marketing

Meat markets in Sri Lanka are controlled by the Muslim community. About 61% of the goat producers in the districts studied were Buddhist. The marketing system in Sri Lanka involves intermediaries called brokers. These brokers either purchase animals from the farmers and supply them to the butchers or introduce the farmers to the butchers. The chain that normally operates in goat marketing is producer–broker–butcher.

Goats are purchased on a live weight basis but no scales are used; the butcher estimates the value of the animal. This system is unsatisfactory because of price

Table 4. Breeds used in different districts (%).

District	L	J	S	K	B	J x L	S x L	K x L	B x L	Nondescript
Anuradhapura	63.3	6.6	-	7.3	0.3	-	-	-	8.3	14.2
Badulla	42.3	14.3	0.1	-	-	22.7	8.0	-	6.3	6.3
Hambantota	91.2	-	-	6.4	-	-	-	-	-	2.4
Kandy	33.4	5.3	7.2	-	-	14.0	9.1	-	-	31.0
Kegalla	54.8	0.9	-	-	-	26.0	16.5	-	-	1.8
Moneragala	26.4	1.9	-	-	-	47.4	-	-	-	24.3
Polonnaruwa	57.0	-	-	-	-	0.8	17.7	-	-	24.5
Puttalam	52.7	0.9	-	-	1.5	11.7	-	-	-	33.2
Average	52.6	3.7	0.9	1.7	0.2	15.4	6.4	-	1.8	17.3

Note: L, local, J, Jamunapari; S, Saanen; K, Kotukachchiya; B, Boer.
Source: Rajaguru and Senanayake (1987).

Table 5. Carcass recovery (%, mean ± SD) of adult goats slaughtered in the Kandy slaughterhouse.

Breed	Live weight (kg)	Carcass weight (kg)	Dressing %
Local (indigenous)			
Male	24.6±3.8	10.5±2.6	42.8±6.8
Female	22.0±3.8	8.6±1.6	40.2±3.9
Average	22.8±3.8	9.5±2.1	41.4±5.6
Jamunapari x local			
Male	25.1±3.5	11.3±2.2	44.6±4.7
Female	28.1±5.3	12.1±3.2	42.7±4.7
Average	26.6±4.4	11.7±2.7	43.6±4.7

Table 6. Size and composition of goat herds in different districts.

Zone and district	Average herd size	Adult males (%)	Adult females (%)	Male and female kids (%)
Dry zone				
Anuradhapura	15.1	12.9	58.9	28.5
Hambantota	32.7	11.2	69.2	19.6
Polonnaruwa	13.3	6.0	53.9	40.1
Dry intermediate zone				
Monaragala	20.6	18.4	50.4	31.2
Puttalam	17.1	9.6	72.1	18.3
Wet intermediate zone				
Badulla	8.0	8.6	47.1	44.3
Wet zone				
Kandy	6.6	4.3	48.3	47.4
Kegalla	8.2	11.3	41.7	47.0

manipulations by the brokers. The farm gate price received by the farmer per kilogram live weight varies between SLR 18 and 28 (in March 1988, 31 Sri Lankan rupees [SLR] = 1 United States dollar [USD]). This price is influenced by the distance from the market and the accessibility of the production area. The present retail price of goat meat ranges between SLR 55 and 80/kg dressed weight. The retail price of goat meat in urban areas is higher than in rural areas. The animals reach the market either by the state-owned railway or by private vans and lorries.

Table 7. Land ownership of farmers by district and zone.

Zone and district	Farmers owning land (%)	Household land (ha)	
		Owned	Not owned
Dry zone			
Anuradhapura	89	2.3	5.6
Hambantota	86	1.6	8.6
Moneragala	80	21.4	-
Polonnaruwa	100	0.6	-
Puttalam	58	1.5	18.8
Wet zone			
Kandy	61	1.2	-
Kegalla	71	1.3	-
Wet and dry zones			
Badulla	50	0.6	-
Overall average	74	3.8	10.9

Source: Rajaguru and Senanayake (1987).

Table 8. Feeding methods used by district and zone.

Zone and district	% grazed		% browsed		% stall fed		% browsed + stall fed		% grazed + stall fed	
	Owned	Not owned	Owned	Not owned	Owned	Not owned	Owned	Not owned	Owned	Not owned
Dry zone										
Anuradhapura	0	0	100	100	22	22	22	22	0	0
Hambantota	0	0	81	58	6	0	0	0	0	0
Moneragala	40	0	60	20	40	20	20	20	0	0
Polonnaruwa	0	0	100	100	50	30	50	30	20	20
Puttalam	0	0	75	58	0	0	0	0	0	0
Avg.	5	0	83	67	29	14	18	14	4	4
Wet zone										
Kandy	36	4	4	0	89	39	0	0	29	0
Kegalla	43	36	14	7	79	29	14	7	43	7
Avg.	40	20	9	4	84	34	7	4	36	4
Wet and dry zones										
Badulla	22	50	11	17	17	50	11	6	11	0

Source: Rajaguru and Senanayake (1987).

There is a deficit of goats in the main consumption areas: Colombo and Kandy (Table 8). For this reason, Sri Lanka must periodically import goat meat (Table 1).

Goat meat produced

The average live weight of a mature local buck slaughtered at the Kandy slaughterhouse is 24.6 kg; that of a doe, 22.0 kg (Table 5). The corresponding live weights for Jamunapari × local goats are 25.1 and 28.1 kg, respectively. Jamunapari × local does are slaughtered at higher body weights because they are slaughtered as culls after their productive life; surplus bucks are sold at 1 or 2 years of age. Table 5 also indicates that the carcass recovery percentages of

Table 9. Average production and slaughter of goats from 1984 to 1986 by district in Sri Lanka.

District	Goat population	Goats slaughtered[a]	Status[b]
Ampara	1127	2680 (23.77)	SS
Anuradhapura	31506	70 (9.22)	S
Badulla	15254	2411 (15.81)	SS
Baticaloa	41432	3925 (9.49)	SS
Colombo	4753	93715 (1971.70)	D
Galle	8556	533 (6.23)	SS
Gampaha	21505	4565 (21.23)	D
Hambantota	6229	388 (6.23)	SS
Jaffna	91257	9204 (10.09)	SS
Kalutara	11253	237 (2.11)	S
Kandy	22557	7900 (35.02)	D
Kegalle	18800	687 (3.65)	SS
Kilinochchi	33608	251 (0.75)	S
Kununegala	49065	2404 (4.90)	S
Mannar	26637	502 (1.88)	S
Matale	11056	1034 (9.35)	SS
Matara	3886	178 (4.58)	SS
Moneragala	4722	510 (10.80)	SS
Mulativu	12228	356 (2.91)	S
Nuwara Eliya	10612	1600 (15.08)	SS
Polonnaruwa	13663	256 (1.87)	S
Puttalam	38002	2260 (5.95)	S
Ratnapura	10760	1739 (16.16)	SS
Trincomalee	25099	856 (3.45)	S
Vavuniya	8307	300 (3.73)	SS
Sri Lanka	511734	138570 (27.08)	

Source: Rajaguru and Senanayake (1987).
[a] Values in parentheses are the goats slaughtered as a percentage of the goat population.
[b] D, deficit region; S, surplus regions; SS, self-sufficient region.

Jamunapari crosses are higher than those of local goats. In fact, the carcass recovery percentages of local goats are extremely low and could be improved by upgrading. In addition, quality of the meat produced is poor because of a high bone to lean ratio. The low quality of goat meat coupled with the high price has caused a low consumer preference in Sri Lanka. Beef and pork retail at prices less than half that of goat meat. It is essential to improve the quality of goat meat and to find ways of reducing the cost of production to popularize goat meat consumption.

Herd improvement for meat production

Sri Lanka does not have a sustained, clear-cut, goat-development policy, even though superior breeds have been imported for herd improvement since 1937. Imported breeds such as Jamunapari, Saanen, and Anglo-Nubian were not used in well-planned breeding programs for herd improvement before 1982. The Sri Lanka – West German Goat Development Programme implemented in five districts in 1982 by the introduction of the Boer meat breed represents the only organized goat-improvement program implemented in the country. This program has had a significant impact in the five districts selected: Anuradhapura, Gampaha, Kalutara, Kurunegala, and Puttalam. It set up goat breeder associations, a goat breeding station to produce Boer crosses for herd improvement, and

an efficient extension program. However, the fact that around 70% of the goats produced in the country were found to be local and of nondescript origin (Table 4) indicates that an accelerated herd-improvement program is essential.

Recommendations

The meat production potential of the Sri Lankan goat population could be improved by classifying goat producers into the following three categories.

Category I

Category I farmers have access to browsing and grazing lands located in the dry and dry intermediate zones. The goats reared are mostly local and local crosses. Because these farmers are mainly interested in meat production, the herds maintained in these areas could be upgraded purely for meat. The breeds that are now used for upgrading are Jamunapari, Boer, and Kotukachchia. These breeds are much heavier than the local breed; therefore, a fast improvement in meat production could be achieved through upgrading or rotational cross-breeding of the local breed with these three breeds.

The merits of introducing these three breeds are as follows. Jamunapari, being a dual-purpose, heavy breed, will help improve the body weight as well as milk output of the local goats. Boer and Kotukachchia, being pure meat breeds with heavy body sizes and superior carcass qualities, will help to increase the carcass quality and weight of the local goats. The limited data collected from the University of Peradeniya goat research unit indicate that an adult Jamunapari buck achieves a body weight of over 70 kg and an adult local buck of the corresponding age weighs only about 35–40 kg. The body weight of a fully grown Boer buck maintained in the government goat-breeding station at Kotukachchiya was reported to be over 80 kg. If the organized herd-improvement program initiated in 1982 is continued, the goat population in the dry and dry intermediate zones could be upgraded to produce at least twice the meat per individual. The data collected from the Kandy municipal slaughterhouse indicate that goats carrying Jamunapari blood to a limited extent produced heavier carcasses and higher carcass recovery percentages than the local goats (Table 5). Also, the herd-improvement program conducted by the Sri Lanka – German Goat Development Programme was able to increase the live weight gain of local male goats in 12 months from 23.2 to 33.7 kg by introducing 25% Boer blood. This information reveals that the goat-breeding program in Sri Lanka will yield positive results.

Category II

Category II farmers are settlers in the colonization programs implemented by the government of Sri Lanka, distributed in the dry and dry intermediate zones. These settlers were allocated 4–5 ha under the old colonization schemes; however, they are given only 1 ha per holding under the present settlement programs. Each settler is provided with about 0.75 ha of irrigable land, mainly for paddy cultivation, and about 0.25 ha of highlands. It may be difficult for these settlers to rear cattle in these limited holdings; however, the introduction of one or two goats to be maintained on the available fodder and crop residues produced is worthwhile.

These farmers can produce the fodder required for a small herd of goats by establishing live fences of *Gliricidia sepium, Leucaena leucocephala, Erythrina*

verieata, and *Thespesia populnea* and by growing bush legumes such as *Stylosanthes* on the paddy bunds. These fodders could supplement the other fodders produced on the holdings and be utilized along with crop residues, for goat feeding.

The recommended goat for this category of farmers is the dual-purpose animal. Such a goat could be produced by crossing local goats with Jamunapari, Anglo-Nubian, or Kamori. The last two breeds would have to be imported to Sri Lanka. The establishment of such a cross would permit farmers to obtain milk for home consumption and to assure a milk supply higher than the production of local goats for the kids. Crosses with a pure milk breed such as Saanen cannot be recommended for these farmers because it has been observed in the cross-breeding programs of the Department of Animal Science of the University of Peradeniya as well as the goat-breeding unit at the Horakele Livestock Farm of the National Livestock Board that the blending ability of Saanen and local goats is poor; the body size and the carcass quality of this cross were inferior even when compared with the local breed. Purebreds other than Kotukachchiya are not recommended for the dry or dry intermediate zones because of their high susceptibility to problems such as hindquarter paralysis and parasitic infections. If a suitable dual-purpose animal is introduced to category II farmers, the goat meat production will increase.

Category III

Category III farmers live in populated regions, especially around urban areas. They are keen to own goats that have a higher potential for milk production with meat as the secondary objective. The highest number of goats reared for milk production are located in these areas, situated mainly in the wet and wet intermediate zones. At the moment, Saanen and Jamunapari crosses are used for milk production. The average yield per doe is 0.5–0.75 L/day.

Saanen × local goats produced in these areas have smaller body weights than improved breeds. It is suggested that the first cross toward the development of an improved milk goat for Sri Lanka should be between the local goat and a dual-purpose breed such as Jamunapari or Kamori or even a meat breed such as Boer. The progeny of such a cross will have a larger body size and a higher milk production than the local breed. If Saanen or Anglo-Nubian are used to upgrade such crosses, increased milk production is feasible. Sri Lanka has not had any planned breeding policy to increase milk production. However, the goat-breeding program started by the Department of Animal Science of the University of Peradeniya in 1983 is expected to produce sufficient data to evolve a milk goat with a higher body weight to also increase meat production potential.

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Goat meat production in Thailand

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Abstract: *Goat production in Thailand is primarily for meat. Approximately 88% of the total goat population is found in villages of the southern region where the Thai Muslim population is relatively high. Goats are traditionally integrated with agricultural systems such as fishing, rice growing, and rubber, oil palm, or fruit tree plantations and are raised by small-scale farmers who own about 1.4 ha/family. Although the flock size in southern Thailand is small (5 head/family), the contribution of goats to the farm cash income is relatively high, especially in a rice-growing system (approx. 56% per year). More than 65% of goat owners employ a tethering system; a cut and carry system is practiced only in the wet season. Cash inputs, concentrates, mineral supplements, and medical treatments are minimal. Village goats are mainly indigenous with average mature body weights of 23 and 22 kg for males and females, respectively. Average growth rates to 6 months of age were 62 and 47 g/day for males and females, respectively. Age at first kidding was 12.4 months. An average kidding rate for all age groups is 190%, but the weaning rate is only 135%. A high mortality rate of 25–37% in young kids is mainly caused by accidents (such as dog bites) and diseases (such as scabby mouth or pneumonia). Under improved conditions, body weights of village goats increased by 21–55%; the kidding rate is somewhat lower (147%) and the weaning rate is higher (146%). However, the improved conditions have little effect on dressing percentage of the native goats (45.8 vs 45.0%).*

Résumé: *En Thaïlande, on élève surtout la chèvre pour sa viande. Environ 88 % du cheptel caprin se retrouve dans les villages du Sud du pays, dans lesquels la population musulmane Thai est relativement élevée. De tradition, l'élevage de la chèvre est intégré aux systèmes agricoles : pêche, culture du riz et exploitation de plantations d'hévéa, de palmiers oléagineux et d'arbres fruitiers; ce sont les exploitations agricoles familiales d'une superficie d'environ 1,4 ha qui pratiquent cet élevage. Même si les troupeaux de chèvres du Sud de la Thaïlande sont petits (5 têtes par famille), la contribution de cet animal au revenu de la ferme est relativement élevé, en particulier dans celles où l'on cultive le riz (environ 56 % du revenu annuel). Plus de 65 % des propriétaires de chèvres se contentent de les garder attachées à un poteau et de les abattre à la saison des pluies. Ils y investissent peu d'argent, ont peu recours aux aliments concentrés et aux suppléments minéraux, et se préoccupent à peine de les soigner. Dans les villages, on retrouve surtout des chèvres indigènes dont le poids moyen à maturité est de 23 kg pour les mâles et de 22 kg pour les femelles. Leur taux de croissance quotidien jusqu'au sixième mois est de 62 g pour les mâles et de 47 g pour les femelles. L'âge moyen des femelles à la première mise bas est de 12,4 mois. Le taux de mise bas moyen, tous groupes d'âge compris, est de 190 %, tandis que le taux de sevrage n'est que de 135 %. Le taux de mortalité élevé des jeunes chevreaux (25 à 37 %) est en grande partie attribuable à des accidents (morsures de chien) et à la maladie (bouche scabieuse ou pneumonie). L'amélioration des conditions permet une augmentation de 21 à 55 % du poids des chèvres des villages; celles-ci présentent un taux de mise bas quelque peu inférieur (147 %) et un taux de sevrage supérieur (146 %). L'amélioration des conditions n'a cependant que peu d'effet sur le rendement à l'abattage des chèvres indigènes (45,8 contre 45,0 %).*

Resumen: *La producción de cabras en Tailandia está orientada primordialmente hacia la obtención de carne. Aproximadamente el 88% de la cantidad total de cabras se encuentra en aldeas de la región sur donde el volumen de la población musulmana tailandesa es relativamente elevado. Las cabras están integradas tradicionalmente con sistemas agrícolas tales como el de la pesca, el cultivo de arroz y las plantaciones de goma, aceite de palma o frutos, y son criadas por pequeños agricultores que poseen aproximadamente 1,4 hectáreas por familia. A pesar de que el tamaño del rebaño en el sur de*

Tailandia es pequeño (5 cabezas por familia), la contribución de las cabras al ingreso familiar es relativamente elevada, especialmente en un sistema que se dedica al cultivo del arroz (aproximadamente 56% del año). Más del 65% de los propietarios de cabras emplean el sistema de pastoreo al piquete; el sistema de corte y acarreo (del pasto) se pone en práctica solamente en la estación húmeda. Las inversiones, concentrados, suplementos minerales y tratamientos médicos son mínimos. Las cabras de aldea son nativas en su mayoría, con pesos promedio de cuerpo adulto de 23 a 22 kg para los machos y hembras respectivamente. El crecimiento promedio se alcanza en 6 meses, durante los cuales los machos ganan 62g de peso por día y las hembras 47. El primer parto ocurre a los 12,4 meses. Un índice promedio de partos para todos los grupos de edades es de 190%, pero la tasa de destete es solamente de 135%. Un indice de mortalidad elevado de 25 a 37% en los cabritos pequeños es causado fundamentalmente por accidentes (tales como mordidas de perros) y enfermedades (tales como la sarna bucal o neumonía). Bajo condiciones mejoradas, los pesos a 55%; la tasa de parto es algo más baja (un 147%) y la de destete es mayor (146%). Sin embargo, las condiciones mejoradas afectan poco el porcentaje de los rendimientos de la carcasa de las cabras nativas.

The major species of livestock in Thailand are buffaloes, cattle, swine, chicken, and ducks (OAE 1986); goats and sheep are only important in the southern region (Chantalakhana 1985; Saithanoo 1985). More than 60% of all goats are found in the villages of the Thai–Malaysian border zone where the proportion of Thai Muslim people is high (Suthiwanich 1983; Saithanoo, Kuprasert, Di Donato, et al. 1985). In general, goats are traditionally raised for home consumption or for sale by small-scale farmers as component of mixed-farm agricultural systems (Saithanoo and Norton 1987).

Studies on goat production in Thailand are scarce but, recently, interest in goat research has increased. Most studies have been conducted on research stations and little effort has been made to directly study or improve goat production in villages. Since 1984, the Department of Animal Science, Prince of Songkla University (PSU), in collaboration with the Thai–Australian PSU project has established a long-term study of village goat production in southern Thailand (Jinahyon 1985). Initially, a village survey was conducted to investigate goat production in different farming systems classified as fishing (FS), rice growing (RS), rubber, oil palm, or fruit tree plantation (TS), and the combination of RS and TS (RT). In 1984, village goats (110 does and 16 bucks) were randomly chosen and brought to the University Farm to be used as breeding stock. Since 1985, approximately two-thirds of the does have been inseminated with Anglo-Nubian semen imported from Australia; the remainder have been mated to local bucks. The productivity of local and crossbred goats produced from these matings is being compared under improved management and village conditions.

This paper describes goat meat production systems in Thailand, with particular attention to village goats in the south and discusses the possibility for improved production.

The goat population of Thailand

Goat production in Thailand is primarily for meat (Falvey 1977; Chantalakhana 1985; Saithanoo 1985). Dairy goats are raised in the central region but are estimated to be less than 1% of the total population (Saithanoo 1985). Because of the small scale of production, skin, hair, wool, and by-products from goats are not economically important.

According to the 1978 Agricultural Census Report (Table 1), the total goat population of Thailand was approximately 84,000, 88% of which was found in the south. However, contradictory values have been reported by other sources (e.g.,

Table 1. Number and distribution of goats in different regions of Thailand compared with other important livestock species.

Region	Goats			Ratio of other species to goat			
	Head	Head per holding	Head per 1000 people	Buffalo	Cattle	Swine	Sheep
Central	5639	11.7	<1	91	126	334	2.95
North	3341	4.8	<1	363	296	426	0.18
Northeast	1504	3.2	<1	2420	1128	858	1.14
South	73979	3.2	13	3	10	10	0.17
East coastal zone	5860	3.5	2	22	52	78	0.04
West coastal zone	15330	4.1	16	4	4	6	0.02
Border zone	52789	2.9	26	1	7	1	0.23
Average	84463	3.4	2	66	49	63	0.38

Source: NSO (1980).

Ashzaq and Kitiwan 1976; FAO 1980a, 1983a; DLD 1981; Suthiwanich 1983). For example, an estimate of 222,000 goats in the south made by Suthiwanich (1983) is three times higher than that reported by FAO (1980a, 1983a), DLD (1981), and NSO (1980).

The border zone of the southern region, which covers an area of about 20,000 km^2, has the largest per capita population. In 1979, 61% of the total population in this zone (1.31 million) were Thai Muslims (NRCT 1981). The low proportions of other livestock species to goat emphasizes the importance of goats in this region.

From 1978 to 1983, Saithanoo, Kuprasert, Di Donato, et al. (1985) estimated that the goat population in the south decreased at an annual rate of approximately 2.4% because of the high mortality of young kids and a decrease in breeding stock caused by the high demand and price of goat meat. Unofficial reports cited by Sarobol (1985) and Cheva-Isarakul (1987) indicated that about 1000 goats/month were brought from the south to supply the Bangkok market and that about 2000 goats/month were illegally imported from Burma during the dry season (September–December). According to FAO (1980b, 1983b, 1986), 270 live goats were intermittently imported into Thailand from 1976 to 1985. They were mainly dairy goats used for milking and breeding purposes. Importation of goat and sheep meat in this period was about 27 t/year with an increase of 12% per year. This implies that the in-country production is not enough to supply local demand.

Village goat production

Socioeconomic aspects

The results of a 1987 village survey conducted in 86 villages of the border zone (S. Saithanoo, J.T.B. Milton, W.A. Pattie, and B.W. Norton, unpublished data) showed that 99% of a total of 121 goat owners interviewed were Thai Muslims. They raise goats as a secondary enterprise in their farming systems (FS, RS, TS, and RT). Only 12 and 21% of them raise goats solely for sale and home consumption, respectively; the majority (67%) raise goats for both purposes.

Traditionally, goat production has been inherited from one generation to another. Most farmers (95%) raise goats because they are easily managed, sell for a good price, and need little input. Although the average number of goats per family in the survey areas is small (five), cash income from goats contributes as much as 56% to total annual farm cash income (Table 2).

About 65% of the goat owners interviewed own less land and fewer goats than the average. In the average six-person family, only two help with the major farm work (e.g., plantation, fishing) and one looks after the goats. About 63% of those who manage the goats are women.

Production systems

Village goats are usually grazed on natural grass and weeds available in the area. Since most goat keepers own little land, more than half the goats graze on land other than their own, either public (47%) or private (7%). Tethering is

Table 2. Village goat production to farming systems in southern Thailand.

Farming system[b]	Land owned (ha/family)	Annual farm cash income per family	Goats per family[a]		Income from goats (% of annual farm cash income)
			Does	Total	
FS (20)	0.25	55914	2.4(1-5)	5.8(1-10)	1.70
RS (33)	0.99	3302	2.8(1-6)	5.5(1-19)	55.53
TS (31)	1.85	37011	2.5(1-7)	5.8(1-28)	3.38
RT (37)	1.97	14425	2.4(1-18)	4.8(1-30)	8.83
Average	1.40	24306	2.5	5.4	5.76

[a]values in parentheses are ranges.
[b]The number of goat owners interviewed are show in parentheses. FS, fish; RS, rice; TS, tree crops; RT, RS plus TS.
[c]In November 1987, 26 Thai baht (THB) = 1 United States dollar (USD).

Table 3. Management system of village goat production used in southern Thailand during the wet and dry seasons (%).

Farming system[a]	Tether	Free to roam	Controlled grazing	Cut and carry
		Wet season		
FS (20)	35.0	50.0	5.0	10.0
RS (33)	75.8	9.1	-	15.1
TS (31)	58.1	16.1	-	25.8
RT (37)	78.4	5.4	2.7	13.5
Avg.	65.3	16.5	1.7	16.5
		Dry season		
FS (20)	25.0	75.0	-	-
RS (33)	84.8	6.1	9.1	-
TS (31)	74.2	25.8	-	-
RT (37)	91.9	8.1	-	-
Avg.	74.4	23.1	2.5	-

[a] The number of goat owners interviewed are shown in parentheses. FS, fish; RS, rice; TS, tree crops; RT, RS plus TS.

widely used in all seasons; a cut and carry system is only practiced in the wet season (Table 3). Controlled grazing and extreme grazing is practiced along roads and uncultivated grazing land such as in fishing villages.

Village goats occasionally get extra feed, mostly in the form of tree leaves, when they return to the owner's house in the evening. A few owners use green grass, rice straw, fruit peels, or cereal as supplements and some (34%) give salt to their goats. Only 21% of the owners provide shelters for the goats.

Production levels

Village goats in Thailand are phenotypically similar to the Katjang breed of Malaysia (Falvey 1977; Saithanoo, Kuprasert, and Suttiyotin 1985). They are small with average mature body weights of 23 and 22 kg for males and females, respectively. Because of the several constraints in the villages, their growth rates up to 6 months of age are low (approximately 62 and 47 g/day in males and females, respectively). Higher growth rates are feasible with improved conditions including access to tree legumes and improved pastures, parasite control, and supplementary feeding. Under these improved conditions, the weights of male and female village goats can increase by as much as 56 and 41%, respectively (Fig. 1).

A comparative study of carcass compositions (W. Pralomkarn, J.T.B. Milton, and W.A. Pattie, unpublished data) shows that the dressing percentage, muscle content, and bone content of the male goats (weight range, 9–22 kg) under improved conditions are slightly higher than those under village condition (45.8 vs 45.0%, 69.6 vs 71.3%, and 16.4 vs 17.9%, respectively) and the difference in their fat contents is high (8.8 vs 4.5%).

Reproductive performance and kid mortality

In the villages, bucks are run together with does year-round. Approximately 78% of the farmers slaughter or sell their bucks before 3 years of age, whereas most farmers (79%) keep does until they are 5 years old. Kidding data of 122 does

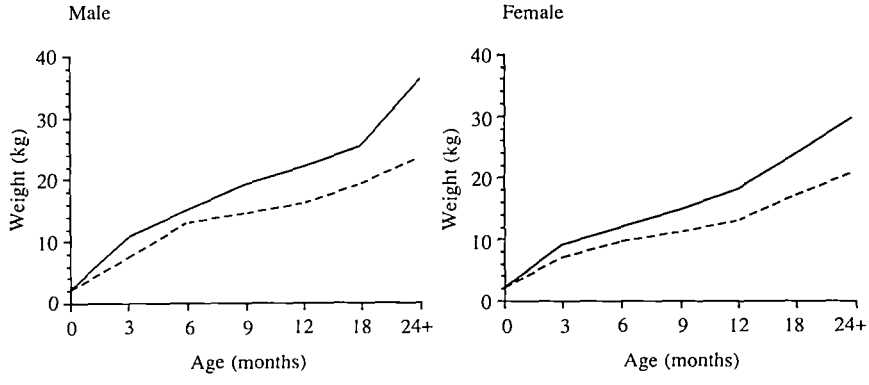

Fig. 1. Comparative live weights of Thai local goats raised under village (dashed line) and improved farm (solid line) conditions.

indicate a peak conception rate (44%) between October and December, which coincides with the period of highest rainfall.

The average age at first kidding is 12.4 months. Because of uncontrolled breeding, about 60% of young females conceive before 7 months of age with some of them (7%) conceiving when they are as young as 3–4 months. Kidding and weaning rates of does less than 1 year old are much lower than those of the older does (Table 4).

The mortality rate among young kids is high (29%) and, of these deaths, most (75%) are caused by accidents such as dog bites or diseases such as scabby mouth or pneumonia. Other causes are poor mothering ability (20%) and abortion (5%). Under improved conditions, the mortality rate in young kids is only 2.3% (Milton et al. 1987).

The kidding rate of village goats is high as does have several opportunities to mate each year. Although the kidding rate under a managed single-mating system at PSU Farm (147%, Milton et al. 1987) appears to be lower than that under the village conditions (190%), the weaning rate is higher (146 vs 135%).

Goat marketing

Unlike other livestock marketing, there is no auction market or selling place for live goats or goat carcasses in Thailand. Traders and consumers have to make direct contact with the goat owners. Goat prices, therefore, vary from place to place and it is difficult to estimate the number of goats sold. The price of goats depends on sex, age, size, appearance, and physical condition (Saithanoo,

Table 4. Reproductive and mortality rates of Thai native goats under village conditions.

Age of doe (years)	Kidding rate (%)	Weaning rate (%)	Preweaning mortality rate (%)
<1	130.8	82.7	36.8
1-2	194.4	131.8	32.2
>2	207.9	155.7	25.1
Average	189.6	134.5	29.1

Table 5. Prices (THB/head)[a] of live goats in southern Thailand in 1984 and 1987.

Age (years)	Sex	1984[b]	1987[c]	Price change (%)
<1	Male	396	544	37.4
	Female	367	433	18.1
1-2	Male	533	710	33.2
	Female	393	485	23.4
>2	Male	550	740	34.6
	Female	398	486	22.1

[a]In November 1987, 26 Thai baht (THB) = 1 United States dollar (USD).
[b]Source: Saithanoo, Suttiyotin et al. (1985).
[c]Source: S. Saithanoo, W.A. Pattie, and B.W. Norton (1987), unpublished data.

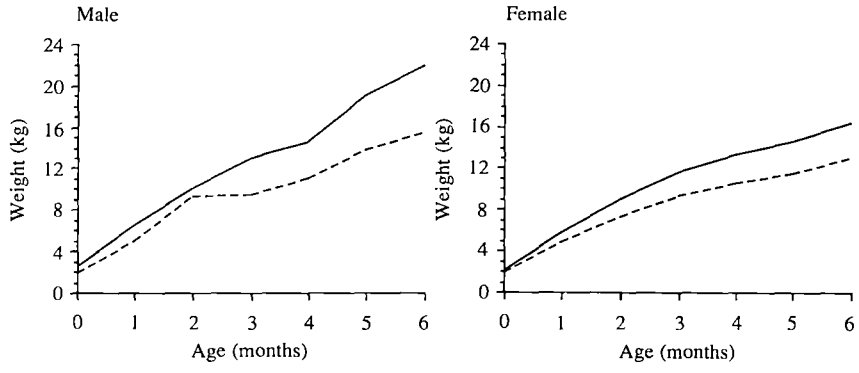

Fig. 2. Comparative live weights of local (dashed line) and crossbred (local x Anglo-Nubian; solid line) goats under an improved management condition.

Suttiyotin, et al. 1985). Live goats are usually sold on a price-per-head basis. Goat prices have increased by 18–37% or approximately 9% per year from 1984 to 1987 (Table 5). Saithanoo, Suttiyotin, et al. (1985) also reported that goat meat was 90, 26, 30, and 43% more expensive than that of buffaloes, cattle, swine, and chicken, respectively.

The major consumers of goats in Thailand are the Muslims. Apart from seasonal demands for religious rites, goat meat is gaining general acceptance in Muslim and Chinese restaurants.

Future development of goat production

Because most goat meat production is in the hands of the small-scale farmer, any development program should aim to improve productivity at the village level. Goats in the villages are generally small but they may be well adapted to the environment. Goat production levels are markedly increased under improved conditions (Fig. 1). Even with available labour and feed resources, there is a high potential for goat development in the villages in terms of both quantity and quality of meat. A comparative study of local and crossbred goats under improved conditions shows that F_1 crossbred goats are much bigger than local goats despite the low milk supply from the local does (Fig. 2); J.T.B. Milton and S. Sripongpun, unpublished data). The real value of the crossbred animals, however, will not be determined until a later stage of the project when the crossbred goats will be tested on farms.

Considering the increased demand for goat meat, goat development in Thailand needs urgent attention. To improve the productivity of goats in the villages, a knowledge of breeding and management systems is important. In addition, particular attention to health care and nutrition during the wet season is needed to overcome high mortality rates. Finally, costs and returns of production should also be considered before extending any development programs to a large number of the farmers.

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Discussion

The first paper in this session dealt with goat meat production in Bangladesh. The per capita consumption of goat meat in this country is 2.3 g/day or 3.98 kg/year. Goat production is becoming more popular in Bangladesh because of the limited land availability; from 1971 to 1983 goat meat production increased 19.1%. The middleman and the butcher play dominant roles in the marketing system, and goat meat fetches a better price than other meats. Five solutions were suggested to the goat production problems of Bangladesh:

- Government intervention to overcome the shortage of breeding material,
- Courses on goat production at the high school level,
- A planned, sustained development program on goat production,
- Popularize goat production using mass media, and
- Encourage problem-solving research.

Improvements in the goat development programs have caused the rapid increase in the goat population over the last 10 years. Black Bengal has not been upgraded, however, to preserve its prolificacy and hide quality. The low milk production of this breed contributes to the high kid mortality in litters larger than two kids. During the discussion it was recommended that studies to identify the level of indiscriminate slaughter be undertaken to eliminate this practice. The discussion also pointed out that the producers in Bangladesh receive only USD 3–4 for a goat valued at USD 6–7.

The annual production of goat meat in China is about 476 × 106 kg. The goat population is declining in China, the rate of decline differing from region to region. The major goat-producing areas are in the south and northeast (Mongolia), where population densities are high. Of the 25 breeds in China, 11 are considered meat breeds. White goat, Matou, Huai, and Cheng du are the most important meat breeds. Although goat production in China is generally in the hands of the poor, pasture areas are being developed for large-scale goat production. During the discussion, the "net meat rate" was explained to be the percentage lean of the carcass.

In India, the average meat production per goat is estimated at 9 kg. Crossing taller and shorter breeds has increased carcass weight 34–40%, but the bone to lean ratio was reduced. Stall feeding has given better weight gains than range feeding. In the goat marketing system of India, the middleman gets 40–45% of the price; the producer, 12–13%.

During the discussion following this paper, the Sirohi was explained to have originated with a people called Sirohi, who are vegetarians. The introduction of new blood to improve meat production has been limited; this has also been the case for dairy goats. Considering embryo transfer as a method of herd improvement, it was pointed out during the discussion that this procedure will definitely

help to preserve valuable, limited gene pools. There have been no attempts to reduce the number of breeds maintained.

The fourth paper in this session dealt with goat meat production in Indonesia. The small size of the landholdings in populated areas has induced the farmers to undertake goat production. The daily consumption of goat meat in Indonesia is 2.5 g/caput. The price of meat varies with demand and is influenced by the occurrence of festivals, etc. Apart from the meat, the offals are liked by the consumers. During the discussion, it was revealed that the long kidding interval of Indonesian goats is due to the low planes of nutrition and stall feeding, making heat detection difficult.

The fifth paper in this session dealt with goat meat production in Malaysia. Goat meat and mutton account for only 8% of the total meat production of Malaysia. Livestock is mainly raised on mixed farms throughout the country. Constraints to goat production included the poor genetic material, inadequate nutrition, and lack of farmer interest. Katjang, Saanen, Anglo-Nubian, Jamunapari, and some Barbari are the breeds of interest in Malaysia. The average daily weight gain of Katjang ranges from 40 to 60 g. An extensive study has been conducted comparing 103 muscles of goat and sheep. There is no organized marketing system for goats in Malaysia. Discussion highlighted high mortality, price disincentives, and poor extension services and the major constraints to goat meat production. The wisdom of importing 9 million sheep into Malaysia and kid mortality were also discussed.

In Nepal, goats are more numerous in the east than in the west. People have a preference for goat meat and the meat price has increased at 13.5% per year. The crossbreeding of local animals (mainly Katjang) resulted in increased body size but reduced the incidence of multiple births. The discussion following this paper centred around the growth rate of crossbreeds and the indiscriminate crossing of local goats. It was indicated that the milk production of Jamunapari cannot increase beyond 58.6 L/lactation. The use of Saanen had been considered, but there was difficulty in importing bucks.

The next paper discussed the present status of goat meat production in Pakistan. There are as many as 25 breeds of goat in Pakistan, 10 of which were recently documented at Sind Agriculture University. Teddy and Beetal show daily live weight gains of 77–80 and 230–264 g, respectively. The price of goat meat has risen from PKR 16 to 30 in 4 years. Besides unauthorized slaughter (4–5%), goats are slaughtered in 292 slaughterhouses. By-products are being minimally utilized. The following recommendations were made:

- A coordinated, multilocational program should be established to evaluate production traits of various breeds;
- Meat characteristics need to be studied;
- Slaughterhouse facilities must be improved;
- A low-cost goat feeding system needs to be developed;
- Marketing facilities must be organized; and
- There is an urgent need to train both farmers and butchers.

The discussion following this paper centred around the high growth rates of some indigenous breeds. The values quoted were relatively high and require verification.

The eighth paper in this session discussed the problems of goat production in the Philippines with reference to the following aspects: low productivity of mature goats; high kid mortality; poor nutrition and management practices; discrimination against goat meat, which is likely due to its inavailability and high price compared with other meats; and marketing constraints. Discussion focused on the need for improved feeding, management, and disease control. It was suggested that the production potential of mature goats raised under optimum systems of feeding and management must be studied before embarking on a crossbreeding program with exotic breeds. The integration of goats with coconuts must be investigated and was considered a high-priority area.

In Sri Lanka, local goats have certain virtues that imported goats lack. The potential of local goats, however, has not been studied. Farmers prefer local, disease-resistant goats. The annual per capita consumption of goat meat in Sri Lanka is only 0.09 kg. One reason for this is that goat meat is more expensive than other meats. The discussion following the Sri Lankan paper centred on the crossbreeding program. It was pointed out that the crossbreeding work in Sri Lanka, especially that with German Boer goats, should be made available to other Asian countries.

The last paper in this session covered goat meat production in Thailand. Most goat raisers in Thailand are landless. The production level of village goats could be markedly increased by improving feeding and management conditions. Discussion centred on the potential of native breeds and the need to study these breeds under optimum feeding and management conditions and to carefully select the breeds for meat production. More collaboration with international organizations was considered desirable.

Session IV

Economics and Marketing

Economics of goat meat production

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Abstract: *An institutional economics approach is applied to goat meat production issues on small farms and among landless producers. Research has demonstrated the soundness of modern goat husbandry practices; however, the economics of production needs further investigation. Present thrusts in economics and systems research are discussed. Microeconomic analysis has limited use unless backed with appropriate macrounderstanding. Economic evaluation of new goat meat production technology requires introduction of an on-farm animal research and extension perspective in national programs. A research agenda appropriate for understanding economic factors contributing to goat production is presented.*

Résumé: *L'auteur applique les méthodes économiques à l'étude de la production caprine chez les petits agriculteurs et les producteurs sans terre. La recherche démontre la qualité des méthodes modernes d'élevage caprin; il reste à étudier les aspects économiques de la production. Il aborde les tendances actuelles de la recherche en économie et sur les systèmes. Sans une vue d'ensemble, l'analyse micro-économique n'a que peu d'utilité à moins de s'appuyer sur des analyses macro-économiques. L'évaluation économique des nouvelles techniques de production de viande caprine nécessite l'introduction de la recherche caprine à la ferme et le souci de la vulgarisation dans les programmes nationaux. On y présente un programme de recherche propre à la compréhension des facteurs économiques relatifs à la production caprine.*

Resumen: *En este trabajo se aplica un enfoque económico institucional a cuestiones relacionadas con la producción de carne de cabra en pequeñas granjas y entre los productores sin tierra. La investigación ha demostrado lo adecuado de las prácticas modernas de crianza de cabras; sin embargo, es necesario investigar más la economía de la producción. Se discuten las actuales tendencias en economía y en la investigación de sistemas. El análysis microeconómico tiene uso limitado a menos que esté apoyado por una macrocomprensión adecuada. Para hacer la evaluación económica de la nueva tecnología de producción de carne de cabra se require introducir la investigación animal en la granja y extender la perspectiva de los programas nacionales. Se presenta una agenda de investigación apropiada para comprender los factores económicos que contribuyen a la producción de cabras.*

Economic analysis of goat production systems has received increased attention in recent years. The technical feasibility of goat production under different management systems is better understood than the economics (Devendra and Burns 1983). The real contribution of goats to small farm income requires further analysis. Some studies point to the profitability of goat rearing on small farms and commercial enterprises. Because most small farmers raise dual-purpose goats, a variety of small-farmer needs such as children's education, petty cash, and family nutrition can be met (Soedjana et al. 1984). However, mere cost and return analysis customarily reported by research stations and extension departments is of little value to the farm community. Economists can significantly contribute toward a better understanding of goat production systems if they take an eclectic viewpoint, implying comparative economic analysis of the following:

- Alternative small-farm enterprises that require small investments similar to goat rearing;

- Institutional set ups to foster the dissemination of improved goat production technology;
- Evaluation of incentive schemes, impact of government policy instruments like price supports, and input subsidies; and
- Provision of low-cost information and economics of veterinary health.

This requires a combined approach to production and marketing and an explicit realization of the social goals and aspirations of small producers.

Economics as a subject is concerned with the allocation of scarce resources to meet unlimited desires in a fashion that leads to greater satisfaction. It deals primarily with evaluating the effects of marginal changes and quantifying their implications for the individual, firm, or society. Good policies require both sound economic analysis and political will. The latter is often missing.

Traditionally, emphasis has been on studying commercial farms whose managers have some training in basic economic principles of production and marketing. This research is easy to conduct because most large commercial farmers are willing collaborators, good records are often maintained, and such farms are conveniently located. However, limited information is available to the livestock researcher or the farmer interested in the economic aspects of goat production on small, isolated farms.

The market serves the useful function of signaling allocation of resources, timing of production, and decisions on sale, provided there are not too many distortions and government regulations. Access to such market information is restrictive, however, especially to small producers located in distant places. Middlemen take full advantage of this poorly coordinated information flow. Therefore, developing a capability in economic analysis is essential for agencies involved in researching new technologies and providing extension advice to farmers. Regular reports on cost and returns, input and product price variations in different markets, and government incentives to promote goat meat production should be summarized and made available to extension workers on a regular basis.

The purpose of this paper is to briefly address the economics of goat meat production on mixed noncommercial farms and by landless agricultural labourers. Because pastoral and nomadic goat production systems tend to be highly specialized and not representative of the average farm, they are excluded from the discussion.

Recent research on goat production systems

Over the past decade, considerable research has been carried out on various aspects of small ruminant production. Winrock International has been actively associated with the economic and systems component of the Small Ruminant Collaborative Research Support Program, title XII research project funded by the United States Agency for International Development. The economic component of this project has the following four objectives (Blond 1983).

- Characterize the existing production systems, including input–output relationships, the role of risk in decision making, and the overall economic rationality and efficiency.
- Study the constraints in transportation, processing, pricing, and storage systems as they relate to producer incentive and market efficiency, and how these may be modified to accommodate improved production practices.

- Study the availability of key inputs for the implementation of new recommended practices, including physical inputs, technical assistance, and credit.
- Assess the likely and actual impacts of proposed and implemented new production practices, especially as they concern nutrition, employment, income distribution, and local village economics.

The project has established small ruminant field research laboratories in different parts of the world. In the Asian region, field research is concentrated in Indonesia. Emphasis has been on the economic evaluation of new technologies, e.g., breeds, nutrition, health, and management on small farms. Besides direct involvement in research, the project aims to strengthen training in livestock by sponsoring in-country workshops on economic analysis of goat production systems, preparation of audiovisual aids and dissemination of information on small ruminants. The International Development Research Centre and the Food and Agriculture Organization of the United Nations play similar roles by organizing professional meetings where researchers can exchange ideas on current developments in small ruminant research.

A major concern

Despite the availability of modern technology for goat meat production, marketing, and processing, there have been limited benefits for the small farmer. Observations on the small farm situation in Pakistan for over 20 years suggest that it has remained unchanged. My grandparents, who have been small farmers for several generations, do not recall any changes in livestock technology, with the exception of some improvements in health care and vaccination campaigns. The latter measures do not contribute to increased productivity, but help in achieving yield stability. With crops, the situation is quite different.

In developed countries, the rapid expansion of commercial poultry and swine production can largely be attributed to the strong vertical and horizontal coordination of production, marketing, and processing functions, often with strong private sector participation. By comparison, it is unclear whether it is the lack of technical know-how (as some complain) or an inability on the part of national programs to translate and integrate the available knowledge on goat production into a viable technology package. It is more appropriate to develop a set of recommendations according to the needs of clients. Because most goat production operations are handled by women and children, extension programs targeted at improving the husbandry skills of these two groups would have a higher payoff than educating older farmers not directly involved in goat rearing.

From a research and development perspective, there is a need for a livestock representative. The rapid spread of the green revolution and the technology related to this can be attributed to the campaigns of the Nobel Laureate Dr Norman Borlaug. He was instrumental in promoting the Mexican wheat varieties that lead to dramatic increases in wheat productivity. Similarly, the International Rice Research Institute, located in the Philippines, participated with national programs to bring high-yielding rice varieties directly to the farmers. Wheat and rice are the major staples and national programs took keen interest in the new technology. By comparison, it is unfortunate that livestock in general and small ruminants in particular lack both international and national representatives. Although the debate on technology improvements for goat meat production should continue, the application of available technology to stimulate production represents a major chal-

lenge. It will be the integrators and synthesizers of information who will lead the way and not necessarily the technologists. Unfortunately, these skills are scarce, costly, and often beyond the reach of many developing countries.

With governments genuinely interested in increasing small ruminant productivity, leadership must rest in the hands of those few who can articulate the needs of farmers, influence government policy to support programs that affect the small farmers, and ensure sufficient continuity for achieving sustained increases in production. The gap between farm productivity and potential production is large enough to warrant immediate attention by policymakers.

Elasticity considerations

The demand for goat meat is directly related to changes in income. Some estimates indicate income elasticity of demand being greater than unity. For example, if national personal income increased by 10%, demand for goat meat would increase by more than 10% on average. With improvements in per capita income, an increased demand for goat meat can be expected in the future in many Asian countries, especially where there is a preference for goat meat.

Economics of goat meat production

Most people consider livestock economic analysis as only being concerned with the cost and returns or supply and demand analysis of the enterprise. This is partially true; however, such an analysis only tells one side of the story. The question of economics has to be looked at both from a microlevel (i.e., the farm/firm level) and the macrolevel or aggregate level of the economy.

Profitability, considered synonymous to economics, is only one of the many criteria used by farmers in making decisions. In the case of goat production, others include risk aversion, overcoming subsistence, income generation, family nutrition, means of investment, and inability or social unacceptability to participate in other activities because of lack of skills or social standing.

Whatever the economic motive, there is general consensus that farmers allocate resources efficiently (Shultz 1964; Hopper 1965). Farmers invest time, effort, and limited resources in activities that result in maximum benefit (not necessarily income) given a risk-prone environment. Therefore, to answer why farmers do what they do, factors influencing a series of decisions must be understood. A mere look at the cost of inputs, levels of use, and returns realized from the sale of the produce fails to explain the underlying decision-making process. Because farmers vary input use according to price, the analyst can only be certain about how the product–price relationship will change over time with a monitoring and evaluation system that updates information on a regular basis.

At the microlevel, economic analysis should answer three fundamental questions related to production: what to produce, how to produce it, and how much to produce. The different alternatives of what to produce should be evaluated and made available to the farmer. Obviously, each alternative will be constrained by the farmer's resources. The production method relates to technology. No single recommendation can be developed for goat production, even though it is easier to generalize livestock practices than crop technology, which is more prone to environmental changes. The production method will depend on the technology avail-

able to the farmer and the farmer's knowledge of the production process. Questions such as breed type, quantity of feed to use, housing of animals, and use of labour will differ with the type of farm. The quantity to produce is partially determined by the market. Small, landless groups find this decision to be the most crucial. Optimal herd size, herd age structure, and the demand and supply of goat meat in the market are all important factors.

Input costs

The feed component often requires a cash expense and labour is usually provided by the family. Child labour is extensively used in the upkeep of animals on small farms (Amir and Knipscheer 1987b). This allows farm families to diversify the use of adult labour, which is used for more difficult tasks like ploughing and transplanting. Among landless classes, there may be further constraints on opportunities for productive work. In surplus labour situations, the value of labour may be minimal if not zero. In cost and return analysis, the shadow price of labour should be used. Farmers do not attach a high value to child labour. Although the opportunity cost of such labour may be high, the child may be losing the opportunity for a proper education.

Feed costs include the purchase of forages, grains, supplements, and minerals. Farmers rarely provide prepared supplement mixes. Different salt and mineral mixes are common in Asia, and these costs should be estimated on a flock basis and several budgets prepared for sample farms. Large surveys that average expenditures across farms provide little information for deriving meaningful recommendations. A summary of costs among users of a particular set of practices versus nonusers is more appropriate.

Variable costs associated with electricity, fuel, medicine, and depreciation should be estimated to represent average conditions. Fixed costs on construction of shelter are often overestimated. Care should be taken when valuing the initial stock buildup. Many farmers prefer purchasing young does over adult bucks. This substantially reduces initial fixed costs. The farmers' own labour is highly valued and there is a tendency to overprice materials gathered from the farm (e.g., mud and sticks) in the Indian subcontinent. Only cash expenses such as roof material, strings, and polythene should be included. Costs should not be estimated based on a standard housing design developed at a research station.

Returns

The direct benefits of goat rearing are live animal sales, changes in herd inventory, milk consumption or sales, and possible manure sales. Methods for estimating these returns have been discussed by Amir and Knipscheer (1987a, 1988). These methods include partial budgeting, gross margins, financial analysis, and production function estimation. Local preferences such as castrated versus noncastrated male goat meat, goat age, colour preferences, and hairy versus nonhairy goats should be valued appropriately. Variations in local practices should be documented with reasons for the preference.

Cost and return analysis

The cost and return analysis from Indonesia shown in Table 1 pertains to a semicommercial farm; the approach for estimating costs on a noncommercial farm is identical. Meat production is estimated based on carcass weight. Direct

Table 1. Costs and returns (IDR)[a] from small ruminant production of semicommercial farms at two locations in Java, Indonesia, in 1982.

	Cirebon			Garut		
	I	II	III	I	II	III
Costs						
Building	80000	13300	40000	300000	133333	750000
Equipment	18750	19700	33000	25000	30000	30000
Feed	459900	91250	2263000	912500	985500	7300000
Minerals	500	300	1000	500	1000	70500
Medicine	0	4800	20500	6000	141000	30000
Labour	120000	0	1095000	809200	2046800	3510000
Opportunity cost	123750	63000	105000	360000	667500	1920000
Others	0	0	0	0	0	128000
Total	802900	192350	3557500	2413200	4005133	13738500
Returns						
Meat/live-stock	463200	488250	955500	3770550	7584192	28800000
Milk	0	0	2920000	0	0	0
Manure	76650	10800	153300	350400	478150	1460000
Total	539850	499050	4028800	4120950	8062342	30260000

Source: Knipscheer et al. (1983).
[a]In March 1988, 1610 Indonesian rupiah (IDR) = 1 United States dollar (USD).

receipts of the sales of live animals are often better indicators. Costs pertaining to marketing should be excluded from the analysis and documented separately to show overall profitability.

A second example concerns goat meat production in Dera Kher Muqadam in the Punjab. Five small-scale farmers with an average landholding of 4 acres (1 acre = 0.405 ha) were interviewed in November 1987. The objective of this exercise was to gather information on returns to investment in goat production. This data is only illustrative. In deriving meaningful results, the number of respondents should be much higher.

Goat rearing is a secondary source income for these farmers. Farmers kept other livestock such as buffaloes, cattle, and chickens. All five farmers raised their own breeding ram. Each farmer had initially started off with one female goat and later increased the flock size. The common breeds reported by these farmers were Teddy (dwarf) and Barbari. There was an average of two kids per litter. The goats are normally grazed year-round and only fed concentrates during December and January when feeds are in short supply. The cost and return analysis reported in Table 2 is based on the average number of goats owned by five farmers.

Feed

The following ingredients are used in the preparation of feeds: wheat bran (0.5 kg at PKR 2/kg), dry bread (PKR 25/head per day), maize grain (0.25 kg/head at PKR 2.25/kg), and salt (30 g/head per month at PKR 3/kg) (in March 1988, 17.1 Pakistan rupees [PKR] = 1 United States dollar [USD]).

Labour

Goats are grazed for 8 h on government lands and hills. This task is often performed by children with little opportunity for cash income. On average, two family members spend part of their time on managing the goats in such activities as

watering, feeding, cleaning, and guarding against predators. The calculation of opportunity cost is difficult. First, the family members participating in the grazing operation are children less than 15 years old. The main loss to the children is education. The value of education time lost by participating in goat management is an area requiring research. Children less than 15 years of age are paid half the salary of adult workers. This rate has been used in the analysis. Farmers may not value their children's time in the same manner. Landowners, however small, rarely allow their children to work off the farm. Therefore, we should view this cost with skepticism. Although it is a true economic cost, it may not have a high priority in the farmers decision-making. It is estimated that for a 12-unit operation, it takes approximately 8 work hours per day. The wage rate for an 8-h working day is PKR 35.

Housing

Houses are made of mud and stones. Often, the land has a low opportunity cost. A shed worth PKR 3000 will last for 5 years and can house 20–25 goats. This cost is treated as fixed. Depreciation is also a fixed expense. It will occur regardless of whether goats are kept or not.

Other costs

The average cost of medicine was PKR 50/6 months. Some farmers lost animals to predators; this has not been included in the analysis.

Returns

The farmers sell only the bucks and maintain females for breeding. There is also a common practice of exchanging young male kids for an adult goat. Farmers market goats for PKR 350–400 for an adult animal. Adult female goats are valued at PKR 550. The value of manure is PKR 30/animal for 6 months.

Discussion

Cost and return analysis and sensitivity analysis for these goat farms are shown in Table 2. Four scenarios are shown in Table 2. The "actual" scenario is based on estimates made through field interviews. Analysis covers a period of 6 months. "Scenario A" includes an opportunity cost for fixed investment but excludes land value because land is not a consumable resource. No allowance is made for rent, assuming that appreciation in the future value will compensate for rent. This only affects the fixed cost, which is not included in the calculation of profit. Therefore, profits remain unchanged. "Scenario B" has the same assumptions as scenario A but incorporates opportunity cost of capital or bank lending rate assumed at 12% per year or 6% per 6 months. This estimate was derived by accounting for fixed investment (6-month period) and cash expenditures included under the variable cost column. It also includes a value adjustment for child labour to reflect time lost in education. "Scenario C" represents the farmer's perspective on cost and returns. This is a more realistic view and perhaps the one under which farmers make decisions. Note that labour is valued much lower than it is by the researcher, especially the value of child labour. Feed costs are reduced to reflect variation in input use and utilization of on-farm feed resources. Farmers do not value wasted bread as the economist does!

Note that although farmers view differences in costs, there are no major differences in returns. A number of points are worth noting. Economic analysis provides a true cost to the use of resources and financial analysis is the accounting procedure that focuses more closely on actual expenditures and earnings. Although farmers are good economists, they do not value resources in the same

Table 2. Cost and return analysis (PKR) of goat meat production in Dera Kher Maqadam, Punjab, Pakistan.

		Scenario		
	Actual	A	B	C
Fixed costs				
Stock[a]	2200	2000	2000	2000
Shed	3000	4000	4000	2500
Total	5200	4000	4000	2500
Variable costs				
Feed[a]	1492	1492	1492	900
Labour	4600	4600	7000	1500
Medicine	50	50	50	25
Mortality	500	500	500	500
Others	65	65	65	0
Interest foregone	0	0	0	0
Total	6707	6707	9272	2925
Returns				
Value of six males	2700	2700	2700	2700
Value of six females	3300	3300	3300	3300
Manure	450	450	450	450
Total	6450	6450	6450	6450
Profit[b]	-257	-257	-2822	3525

Source: Muzaffar Iqbal Bhatti, personal communication (November 1877 survey).

[a]Four goats at PKR 550/goat. In March 1988, 17.1 Pakistan rupees (PKR) = 1 United States dollar (USD).

[b]Profit = returns - variable costs.

manner as treated by professional economists. Therefore, one must not be confused at the different estimates one arrives at using alternative assumptions. Such results should not be dismissed without careful evaluation, especially when negative profits appear, and the economist erroneously concludes that the enterprise is not profitable.

With limited opportunities for investment, security, and steady cash flows, returns to investment in goat meat production are adequate, provided the assumptions with respect to labour, feed costs, use of household refuse such as bread, use of by-products, and traditional low-cost veterinary practices are handled with care. There is always a tendency among farmers to report high costs and low returns. Laying one's hands on the cash costs and those considered important by the farmer are key to sound economic analysis.

Research Agenda

Within the research program, because of limited resources, only key research questions with potential payoffs should be addressed. The following five topics can be included within national programs.

First, where economists are available, they should be included in multidisciplinary teams to look at constraints, productivity gaps, and opportunities at the farm level. Each technical recommendation should be supported with basic economic analysis. Some of this economic analysis can be performed by non-economists.

Second, small pilot projects with 30–40 collaborators rearing 100–150 does can serve as useful field laboratories. Detailed records should be maintained on inputs, outputs, herd size, animal weights, and mortality.

Third, procedures for careful testing of new technologies to confirm their viability at the farm level have been documented in several studies (Nordblom et al. 1985; Amir and Knipscheer 1987b, 1988; Singh and Ram 1987). These studies provide information relevant to developing on-farm animal research programs.

Fourth, careful summary of important input costs and goat meat prices should be prepared on a quarterly basis. This data set should be analyzed for forecasting price and demand relationships using standard econometric tools. International trade trends should be studied to determine the comparative economic advantage using domestic resource cost analysis.

Fifth, farmer training should be a regular feature of any research station. Unless research results can be communicated to farmers, the research is of little value. Economic analysis can demonstrate to the farmers the profitability or economic advantage of the new practice (e.g., a new breed, use of an antithelmic drench, or use of supplements). Similar investigations into the design of low-cost procedures for disseminating information should receive attention from the economist.

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Marketing of goat meat

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Abstract: *Goats are a major source of meat accounting for about 30% of total meat production in India. About 35 million goats are slaughtered annually in organized slaughterhouses and the average carcass weight is 9 kg. There are innumerable intermediaries in the chain of marketing of live animals and meat, each adding to the retail cost. Most slaughterhouses are managed by municipal bodies and operate as service abattoirs. Meat is mostly consumed within 8–10 h of slaughter. A meat-processing industry with an annual throughput of 55,000 t and infrastructural facilities of freezing and cold storage has been set up. The annual export of meat from India is around 50,000 t. Goat meat constitutes from 4 to 6% of these exports. The export price of goat meat is allowed within a limited ceiling subject to a minimum export price and a compulsory preshipment inspection for quality. The major export markets are the countries of the Persian Gulf. The market situation is depressed and there is fierce competition from mutton marketed by competing countries. Nontariff barriers on animal health considerations have been imposed by some importing countries. The free-on-board price of goat meat has increased by 32% during the last 5 years compared with a 67–77% increase in the retail price.*

Résumé: *La chèvre représente une source de viande importante en Inde et 30 % de la production totale de viande du pays. On conduit chaque année environ 35 millions de chèvres à l'abattoir; le poids moyen de la carcasse est de 9 kg. Le nombre d'intermédiaires dans la chaîne de commercialisation de l'animal sur pieds et de sa viande est immense, chacun d'eux faisant monter le prix de détail. La plupart des abattoirs sont gérés par des organismes municipaux et ont une fonction de service. La majeure partie de la viande est consommée dans les 8 à 10 heures suivant l'abattage. Il y a eu création d'une industrie de la transformation d'une capacité annuelle de 55 000 t, dotée des installations de congélation et d'entreposage nécessaires. L'Inde exporte annuellement environ 50 000 t de viande, dont 4 à 6 % sont de la viande de chèvre. L'exportation de la viande caprine est assujettie à une limite fonction d'un quota d'exportation minimal et à une inspection obligatoire avant son expédition. Les principaux marchés d'exportation sont les pays du golfe Persique. Le marché traverse une crise en raison de la forte concurrence offerte par le mouton qui est commercialisé par d'autres pays; de plus, certains pays importateurs ont imposé des barrières non tarifaires afin de s'assurer de la santé des bêtes. Le prix franco à bord de la viande caprine a augmenté de 32 % au cours des cinq dernières années comparativement à l'augmentation de 67 à 77 % qu'ont enregistrée les prix de détail.*

Resumen: *Las cabras son una fuente principal de carne y constituyen aproximademente el 30% de la producción total de carne en la India. Cerca de 35 millones de cabras se sacrifican anualmente en mataderos organizados y el peso promedio de la canal es 9 kg. Innumerables intermediarios en la cadena que va desde la comercialización de animales vivos hasta la carne aumentan lo el precio de venta. La mayoría de los mataderos son administrador por instancias municipales y operan como mataderos de servicio. La carne se consume en su mayoría dentro de ocho o diez horas después de haberse sacrificado el animal. Se ha establecido una industria procesadora de carne con una producción anual de 55 mil toneladas e infraestructura de congelamiento y almacenamiento en frío. La exportación anual de carne de la India es de approximadamente de 50,000 ton. La carne de cabra constituye de un 4 a un 6% de estas exportaciones. La exportación de carne de cabra se permite dentro de un marco limitado, sujeto a un mínimo de exportación y a una inspección de calidad obligatoria antes del embarque. Los principales mercados de exportación son los países del Golfo Pérsico. La situación del mercado es crítica y hay una fuerte competencia por parte de la carne de carnero comercializada por países competidores. Algunos de los países importadores han impuesto barreras no arancelarias basadas en consideraciones de salud animal. El precio libre a bordo de la carne de cabra ha aumen-*

tado en un 32% durante los últimos cinco años en comparación con un aumento del 67 al 77% del precio de venta.

Goats provide an important source of meat in many Asian countries. In India, goat meat accounts for about 30% of total meat production. It is a well-accepted item among the people. Although poultry and fish have enhanced the availability of animal protein, they serve as supplements to bovine meat. Goat rearing also provides an alternative source of income during periods of crop failure. Realizing its importance, goat rearing has been included in various programs to provide gainful employment, especially among marginal farmers and landless poor.

Meat production

In 1985, 1036 $\times$ 10^3 t of meat was produced in India (Table 1). About 43% of this production is from sheep and goats. Goats, are the principal source of meat, accounting for almost one-third of the total meat production. Annual meat production increased 22% from 1979–1981 to 1985 (Table 1). Goat meat production increased 17% from 1979–1981 to 1985.

About 14.8 million sheep and 35 million goats are slaughtered annually in the organized slaughterhouses. The percentage of animals slaughtered annually in relation to their population has been estimated at 32.5 and 36.6% for sheep and goat, respectively. The weight of a dressed carcass is about 9 kg.

Marketing

Meat marketing involves all the activities from the moment animals are sold by the producer to an intermediary to the stage when meat and other by-products reach the consumers. Under prevailing conditions, the marketing of meat involves many agencies, intermediaries, and middlemen and it is difficult to assess their exact number in an entire operational chain. The many middlemen, in most cases, earn the major part of the total price charged to the consumer.

A study of meat marketing referred to by the National Commission on Agriculture showed that despite increases in the retail price of meat, propor-

Table 1. Annual meat production (x10^3 t) in India from slaughtered animals.

	1979-81 (avg.)	1982	1983	1984	1985
Beef and veal	74(9)[a]	80(9)	80(8)	86(9)	89(9)
Buffalo meat	107(13)	130(14)	132(14)	134(13)	135(13)
Mutton and lamb	120(14)	127(13)	134(14)	134(13)	135(13)
Goat meat	269(32)	288(30)	302(31)	305(30)	315(30)
Pork	70(8)	80(9)	80(8)	82(8)	85(8)
Poultry	111(13)	130(14)	137(14)	150(15)	158(15)
Others	100(11)	105(11)	110(11)	115(12)	119(12)
Total	851	945	975	1006	1036

Source: FAO (1985).
[a] Values in parentheses represent percentages of total meat production.

tionate benefit has not reached the primary producers to provide incentive for more meat production (NCA 1976). Lack of alternative means of marketing and poor retaining power forces the producers to sell the animals at a relatively cheap price. In addition, there is the farmer's attitude to treat meat as a by-product and not as a commodity.

There are about 2800 slaughterhouses in India. Most slaughter-houses are managed by municipal bodies. In addition to the municipal abattoir at Deonar in Bombay, which opened in 1971, modern state-owned meat complexes have been set up in Goa and West Bengal at Durgapur. There are also plans to set up modern abattoirs in Madras, Calcutta, Delhi, Gangton, Bangalore, Srinagar, and Hyderabad. When completed, these projects will supply wholesome meat to the consumers and support a meat export trade. Furthermore, a privately owned industry (Brooke Bond India Ltd) has been established in Aurangabad, Maharashtra.

The slaughterhouses in India, except for a few private ones, operate as service abattoirs. The butchers slaughter animals for a nominal fee. Furthermore, the by-products, both edible and inedible, are sold to the butchers.

Meat processing

Meat is mostly consumed within 8–10 h of slaughter. This pattern is not likely to change in the near future; however, recently, the risk of eating hot meat because of high bacterial contamination caused by poor hygiene has become well known. A private company has already started marketing processed frozen mutton and goat meat in Bombay and Delhi.

Meat handling and transport from abattoirs to markets in hot conditions is generally done rapidly. In some slaughterhouses especially those in metropolitan cities, the abattoir authority provides covered, fly-proof vans to the butchers to transport the meat from the slaughterhouse to the retail outlets. In small places, almost all possible modes of transportation are used to transport the meat. Insulated or refrigerated transport is limited to private exporters or state corporations for the export trade.

To meet export requirements over the last decade, a number of meat-processing plants have been established, particularly in the private sector. In 1981/82, about 55,000 t of processed meat was produced. In addition, the meat plant at Aurangabad produces about 2500 t/year of corned buffalo meat.

Prices and demand

The retail prices of mutton in the Delhi and Calcutta metropolitan markets increased from INR 18 to 32/kg (78%) and from INR 20 to 34/kg (70%) from January–March 1982 to July–September 1987, respectively (in March 1988, 12.2 Indian rupees [INR] = 1 United States dollar [USD]). The retail price of goat meat during the same period increased in Delhi from INR 18 to 30/kg (67%) and in Calcutta from INR 22 to 39/kg (77%) (Table 2).

Looking at the trend of market prices, the income elasticity of demand for sheep and goat meat appears to be quite high. The National Commission on Agriculture estimated the aggregate consumer demand for meat to range between

Table 2. Retail meat prices (INR/kg)[a] of mutton and goat meat in the Delhi and Calcutta metropolitan markets of India.

	Mutton		Goat meat	
	Delhi	Calcutta	Delhi	Calcutta
1982				
Jan.-Mar.	18	20	18	22
Apr.-June	20	21	20	23
July-Sept.	20	21	20	24
Oct.-Dec.	20	22	20	24
1983				
Jan.-Mar.	20	22	20	22
Apr.-June	20	22	20	22
July-Sept.	21	22	21	22
Oct.-Dec.	20	22	20	23
1984				
Jan.-Mar.	20	22	20	24
Apr.-June	20	22	20	25
July-Sept.	20	24	20	27
Oct.-Dec.	21	25	21	30
1985				
Jan.-Mar.	22	28	22	28
Apr.-June	23	28	24	29
July-Sept.	24	29	24	30
Oct.-Dec.	26	30	26	31
1986				
Jan.-Mar.	26	30	26	34
Apr.-June	26	32	26	36
July-Sept.	28	34	28	38
Oct.-Dec.	28	36	28	38
1987				
Jan.-Mar.	28	35	28	38
Apr.-June	30	34	29	39
July-Sept.	32	34	30	39

Source: DES (1982-1987).
[a]In March 1988, 12.2 Indian rupees (INR) = 1 United States dollar (USD).

1.1 and 1.4 $\times 10^6$ t in 1985 and between 1.6 and 2.1 $\times 10^6$ t in 2000 (NCA 1976). It is estimated that goat would continue to provide about 30% of the total meat produced.

Export of meat

The export of meat from India began in the early 1970s. In 1973/74, 2005 t of meat was exported. This included 85 t of mutton and goat meat and 1920 t of buffalo meat. With a boom in the price of petroleum products, meat exports to the Persian Gulf and the Middle East showed rapid growth during the 1970s. Exports reached 54,582 t in 1981/82. The major importing countries were the United Arab Emirates (UAE), Kuwait, Saudi Arabia, Oman, Bahrain, Qatar, and Yemen. Iran also imported meat from India from 1980/81 to 1982/83. The meat exports from India suffered a setback on account of a ban imposed by Saudi Arabia because of the presence of rinderpest and foot-and-mouth disease. This was partially compensated by export to Malaysia, which began importing meat from India in 1982/83. Exports declined to 39,749 t in 1983/84 and rebounded to 48,608 t in 1985/86 (Table 3).

The bulk of exported meat is frozen and vacuum packed. Frozen meat accounts for 65–75% of the total meat export. Substantial infrastructural facilities

have been created for the transportation and storage of frozen meat. Fresh and chilled meat constitute 20–30% of the export. There is a declining trend in the export of fresh, chilled meat because of decreasing demand from importing countries. Because of its limited shelf-life, fresh, chilled meat is transported by air. The export volume of canned meat has been fluctuating, showing a general declining trend.

Buffalo meat accounts for 70–80% of the total exports (Table 3). Mutton accounts for around 20% and the exports have been steady in terms of volume except for a drop in 1986/87. The export of goat meat, which was 1568 t in 1983/84, accounting for 4% of exports, increased to 3153 t in 1984/85 and 2998 t in 1985/86, accounting for 7 and 6% of meat exports, respectively (Table 3). In 1986/87, however, the quantity of goat meat declined to 1064 t. This is because many of the goat-rearing areas have been affected by drought, resulting in a lower availability of animals for slaughter and leading to an abnormal rise in the price of goat meat in the domestic market.

The major markets for mutton and goat meat from India are UAE, Oman, Saudi Arabia, Bahrain, and Kuwait. A small quantity is also exported to other Persian Gulf countries (Table 4). The bulk of the goat meat is exported chilled and fresh by air. These markets have been developed because of their geographical proximity and preference for lean, chilled meat.

The FOB (free-on-board) prices of mutton and goat meat over the last 5 years have not shown any marked changes (Table 5). The FOB price of goat meat increased from INR 18.32/kg in 1982/83 to INR 24.25/kg in 1986/87 (32%). This increase is much lower than the increase in the price of meat in the domestic

Table 3. Export of meat (t) from India.

	1982/83	1983/84	1984/85	1985/86	1986/87
Fresh, chilled	10889	11829	14032	13208	9578
Frozen	40689	2626	29605	34012	36064
Canned	2512	1653	2050	1388	1376
Bovine meat	43176	27770	32303	35400	37440
Mutton	8949	10411	10232	10210	8314
Goat meat	1965	1568	3153	2998	1064
Total	54090	39749	45687	48608	46818

Source: India (1983-1985, 1985-1987).

Table 4. Export (t) of sheep and goat meat from India.

	1982/83	1983/84	1984/85	1985/86
United Arab Emirates	8167	8650	8929	7726
Oman	1465	1628	1986	3188
Saudi Arabia	603	1165	1128	1537
Bahrain	226	381	788	665
Kuwait	-	-	207	20
Qatar	40	-	-	-
Others	453	155	346	72
Total	10914	11979	13884	13208

Source: India (1983-1985, 1985-1987).

Table 5. Free-on-board export earnings (INR/kg)[a] from mutton and goat meat.

Year	Mutton	Goat meat
1982/83	18.26	18.32
1983/84	20.10	20.09
1984/85	19.97	20.49
1985/86	21.95	22.18
1986/87	24.52	24.25

Source: India (1983-1985, 1985-1987).
[a]In March 1988, 12.2 Indian rupees (INR) = 1 United States dollar (USD).

market. The retail price of goat meat increased by 67–77% during the same period, pushing up the FOB cost. The widening gap between the FOB cost and FOB realization has acted as major disincentive for increasing the export of goat meat.

In addition to goat meat, animals on hoof are also exported for meat purposes. On average, between 100,000 and 130,000 goats (mainly males) are exported annually to UAE, Kuwait, Oman, and Bahrain. The export takes place mainly during Ramazan season.

Export policy

The export of mutton and goat meat is allowed within a limited ceiling subject to a minimum export price (MEP). The export ceiling since 1983/84 has been 16,500 t/year (10,992 t mutton and 5,508 t goat meat). About 80% of the ceiling is actually utilized by effecting exports. The MEP has been fixed at INR 19/kg FOB.

The export of live goats is also subject to a limited ceiling and an MEP of INR 12/kg. To preserve important milch and meat breeds, the export of three milch breeds (Jamunapari, Beetal, and Barbari) and one meat breed (Black Bengal) is not allowed.

To ensure that only high-quality meat is exported from India, some stringent measures have been taken. Meat for export must be certified as obtained from healthy animals slaughtered in licenced premises and subjected to antemortem and postmortem inspection according to prescribed procedures. The meat must also have been prepared under hygienic conditions, be wholesome, and be fit for human consumption. The meat-processing plants are also subject to inspection. In addition, every consignment of meat has to be submitted for a preshipment bacteriological examination at a designated laboratory. The minimum quality standards with respect to meat for export have been prescribed. Meat must be free of *Salmonella* (Ministry of Commerce 1985).

Factors affecting meat trade

Until the early 1980s, the demand was particularly strong for mutton and goat meat in the Near East. The Indian meat industry took advantage of this high demand by establishing an export trade of meat and live animals to these countries. Since the early 1980s, the upward trend in meat demand has been

slowed or stopped by economic recession and falling petroleum prices. Many of the countries in the Persian Gulf and the Middle East have also undertaken sizeable poultry production programs. This has also curbed import demand for mutton and goat meat.

The price at which meat can be offered is an important factor in determining demand. The price policies followed by meat producing and exporting developed countries influence the demand for mutton and goat meat in the importing countries. European Economic Community countries have been selling surplus beef in the international market with the help of heavy subsidies, adding to the downward pressure on meat demand. In many importing countries in the Middle East, the prices of beef have declined below the prices for other types of meat. As a result, the share of imports from developing countries like India, which cannot offer meat at such low prices, has declined.

India has also had to compete with countries like Australia, New Zealand, Turkey, and Bulgaria in the export of mutton and goat meat. These countries, especially Australia and New Zealand, have got lower costs of production because of economies of scale and the systems of rearing animals and are, therefore, able to market mutton at a price otherwise not remunerative to the Indian exporter. Chilled goat meat enjoyed a premium price at one time in many markets in the Near East. With changing tastes and food habits, such preferences no longer exist.

The difference between the domestic and export price of goat meat has been increasing. During the last 5 years, while there has been an increase of 67–77% in the domestic retail price of goat meat, the FOB price has increased by only 32%. At present, the FOB realization is about 25% lower than the retail market prices.

Tariff and nontariff barriers

Global arrangements covering the meat trade do not as yet exist. The Uruguay Round of Multilateral Negotiations, when completed, may set the basic principles for negotiations on agriculture in which meat is included.

At present, access to markets in developed countries for frozen meat does not exist because of animal health issues. The United Kingdom has permitted import of cooked meat from India; however, duties make imports uncompetitive. It is felt that animal health considerations are acting as nontariff barriers to India's entry into developed country markets. Although not questioning the need for such measures to protect the livestock in disease-free countries, the way in which these measures are applied sometimes appears to be difficult to justify. Some countries in the Near East have also imposed severe restrictions on meat imports arising from health considerations. Saudi Arabia's ban does not cover the import of goat meat from India. Kuwait, which had banned the import of ruminant meat, has recently removed the restriction after a visit by a team of experts to India to satisfy themselves regarding the requirements of producing and processing meat.

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Potential for goat meat marketing in the Near East region

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Abstract: *The meat supply situation in the Near East, especially in the oil-exporting countries, is characterized by massive imports of slaughter stock as well as chilled and frozen meat. The share of goats and the Asian share in the total meat trade is small. However, there is a growing preference for lean meat and an increasing consumption of frozen meat. The consumption of fresh or frozen goat meat is limited by its availability in the market. Asian exports may be able not only to meet the present demand for goat meat but also to create additional demand because of proximity price competitiveness. There is a potential for marketing goat meat from Asia in the Near East. There is, however, intense market competition, a present glut of goat meat on the market, and a wide availability of cheap, subsidized beef. To develop exports from Asia to the Near East, a detailed market survey and bilateral regulatory arrangements must be made, especially with respect to zoosanitary requirements and certification of "Halal" slaughter. An export-oriented marketing system and production for export also must be developed to sustain a regular export commitment.*

Résumé: *La production de viande au Proche-Orient, en particulier dans les pays exportateurs de pétrole, se caractérise par des importations massives de carcasses d'animaux ainsi que de viande réfrigérée ou surgelée. La part de la viande caprine et du marché asiatique est faible. On note cependant une préférence croissante pour la viande maigre et une augmentation de la consommation de viande surgelée. La consommation de viande caprine fraîche ou surgelée est toutefois limitée par sa disponibilité sur le marché. Les exportations asiatiques devraient être en mesure de répondre non seulement à la demande actuelle de viande caprine, mais aussi de susciter une plus grande demande en raison du caractère concurrentiel des prix dans la région. Il existe des possibilités de commercialiser la viande caprine d'Asie au proche Orient. Il règne toutefois sur le marché une forte concurrence, une surabondance de viande caprine de même qu'une grande quantité de viande bovine à bon marché, dont la production est subventionnée. L'exportation au Proche-Orient de la viande caprine produite en Asie réclame une étude de marché détaillée et l'adoption d'une réglementation bilatérale, plus particulièrement en ce qui a trait aux exigences d'hygiène animale et à la certification d'abattage «Hallal». On devra aussi axer la production sur l'exportation afin d'assurer le maintien d'exportations régulières.*

Resumen: *La situación del suministro de carne en el Cercano Oriente, especialmente en los países exportadores de petróleo, se caracteriza por importaciones masivas de carne de animales sacrificados así como de carne refrigerada y congelada. La parte que corresponde a las cabras y la que corresponde a Asia en el comercio total de carne es pequeña. Sin embargo, hay una creciente preferencia por carne magra y un aumento en el consumo de carne congelada. El consumo de carne fresca o congelada de cabra está limitado por su disponibilidad en el mercado. Las exportaciones asiáticas pueden ser capaces no solamente de cubrir la demanda actual de carne de cabra, sino también de crear una demanda adicional debido a la competencia que resulta del hecho de ofrecer precios similares. Hay un potencial en la comercialización de la carne de cabra que se exportaría de Asia hacia el Cercano Oriente. Sin embargo, hay una gran competencia en el mercado y a la vez un excedente de carne de cabra junto a una amplia disponibilidad de carne de res barata y subvencionada. Para desarrollar las exportaciones de Asia hacia el Cercano Oriente se debe hacer una encuesta detallada del mercado y arreglos regulatorios bilaterales, especialmente con respecto a los requisitos zoo-sanitarios y la certificación de matanza "Halal". También se deben desarrollar la producción y un systema de comercialización orientado hacia el mercado exterior para cumplir con un compromiso regular de exportación.*

Supply and demand

The characteristic feature of the present meat supply situation in the Middle East is the massive increase in importation and almost stagnant production from indigenous resources. Meat production in the region is primarily from the traditional pastoral system, which is now a victim of rangeland degradation. With the greater scarcity of grazing, the range animals depend more and more on cereal cropping areas for crop residues and other feedstuffs. In recent years, intensive production of red meat based on concentrate feeds and good-quality pastures has also become popular.

The meat/feed price ratio is favourable in most countries of the Near East, especially in countries that import most of the feedstuffs required. The high demand and rising prices of both beef and mutton offer an economic opportunity to establish cattle- and sheep-fattening enterprises in almost all countries of the Near East region. The problems associated with the development of feedlot enterprises in the region are mainly proper management and procurement of feeder stock.

A look at the self-sufficiency ratios in the Near East during the past decade shows that, except for poultry meat and eggs (based on indigenous or imported feedstuffs), the reliance on imports to meet the demand has been rising. Exports from some countries (e.g., Mauritania, Somalia, Sudan, and Syria) have dwindled and, at the same time, consumption has increased. The consumption patterns for foods of animal origin have changed dramatically in most Near East countries. Growth in the consumption of poultry meat has been the highest. The largest gap between production and demand is that for red meat, especially mutton and goat meat (Qureshi 1987).

Meat is the favoured food of the region. The average annual consumption per person varies from about 11 kg in Algeria and Morocco to 50 kg in Somalia, 83 kg in Qatar, and 110 kg in the United Arab Emirates (UAE). Mutton and goat meat are preferred the most, but the growth in the consumption of poultry has been high, mainly because of its increased supply. The imports of red meat and live animals for slaughter have burgeoned in the oil-exporting countries and have rapidly increased in some nonoil-exporting countries. In the oil-exporting countries, a large proportion of red meat consumed comes from imports. Among the nonoil-exporting countries, the major importers are Egypt, Jordan, and the Yemen Arab Republic.

Growth in consumption and import is similar in the cases of mutton and goat meat as well as for beef (Table 1). Poultry meat imports, however, have been variable depending on the growth in indigenous production. Iraq, Kuwait, Libya, Saudi Arabia, and UAE have substantially increased their imports to meet the demand for red meat.

The exports of goats by Somalia and Turkey are usually well reported and recorded in the Food and Agriculture Organization (FAO) data base. The import of Asian goats in the Persian Gulf countries does not seem to be reflected in these data. The available data indicate a preference in recent years for the import of live sheep rather than their meat (Table 2). However, in Iran, Jordan, and Oman, the trend has been toward the import of meat mainly for logistic and animal-health reasons.

Table 1. Increase in the total consumption (C) and imports (I) ($x10^3$ t) of various meats in major importing countries.

Country	Years	Mutton and goat meat		Poultry meat		Beef	
		C	I	C	I	C	I
Democratic Yemen	1974-76	11	1	1	0	2	0
	1979-81	12	3	5	4	3	1
	1982-84	12	4	8	7	5	2
Egypt	1974-76	46	1	97	0	262	34
	1979-81	49	6	174	56	325	91
	1982-84	48	2	217	46	442	188
Iraq	1974-76	67	6	36	7	51	4
	1979-81	84	20	165	109	79	30
	1982-84	78	25	211	104	144	107
Kuwait	1974-76	20	21	20	16	5	5
	1979-81	36	37	38	38	12	15
Saudi Arabia	1974-76	32	12	59	42	14	11
	1979-81	96	70	216	173	68	62
	1982-84	127	90	336	199	154	138
United Arab Emirates	1975-76	8	11	13	14	3	3
	1979-81	21	27	38	42	4	3
Yemen	1974-76	41	0	2	0	12	1
	1979-81	44	3	49	45	14	4
	1982-84	46	3	52	42	14	4

Characteristics of the Near East market

Imported meat and meat animals are the primary sources of urban supply in the major importing countries. Market segments in the oil-exporting countries are somewhat different from the other meat-importing countries. In the latter group of countries, the markets are basically divided among the various income groups, especially in the urban centres. In the oil-exporting countries, there are two distinct market segments: the local population and foreigners.

The local population consumes mainly fresh lamb, mutton, and goat meat. The high-income group prefers to buy live animals for home slaughter usually at a relatively higher price than that charged for meat of similar quality. The foreigners, who account for a high percentage of the population in most countries, consume all kinds of imported meats, mostly frozen beef or mutton. Recently, there has been a trend in favour of frozen meat among the local populations. Chicken is mostly purchased frozen.

There is a wide variation in the retail prices at butcher shops and supermarkets (Table 3). The butcher's margin is also high. A comparison of cost + insurance + freight (CIF) values reported in Table 2 and the retail prices of imported stock in local markets shows a high trade margin for internal trade.

In the Persian Gulf countries, the most preferred meat is that of freshly slaughtered, fat-tailed sheep. The local sheep or those imported from Turkey or Syria are purchased live and are usually slaughtered at home. These sheep fetch top prices and their demand does not yet seem to have been saturated. The second category in the price range includes imports from Somalia and Australia.

Table 2. Import of sheep and goats and their meats in the Near East.

Country	Year	Live sheep		Live goats		Mutton	
		x10^3 head	USD/ head	x10^3 head	USD/ head	t	USD/t
Bahrain	1981	130	77	50	88	1275	2921
	1986	250	64	-	-	1400	2143
Democratic Yemen	1981	150	78	-	-	1069	2192
	1986	193	46	-	-	300	1500
Egypt	1981	1	45	-	-	7872	1586
	1986	88	57	-	-	3000	1333
Iran	1981	461	32	-	-	125000	1760
	1986	-	-	-	-	155000	1710
Iraq	1981	110	57	-	-	30700	2117
	1986	350	60	-	-	20000	1600
Kuwait	1981	1517	67	-	-	13382	2028
	1986	2400	57	-	-	6000	1833
Lebanon	1981	250	66	70	71	5000	1800
	1986	150	67	50	104	500	1900
Libya	1981	2502	108	-	-	6328	3506
	1986	1400	80	-	-	1000	2700
Oman	1981	67	60	-	-	7795	2457
	1986	150	48	-	-	12800	2240
Qatar	1981	400	61	-	-	1275	2102
	1986	705	48	-	-	1250	2240
Saudi Arabia	1981	5946	83	82	90	32801	2391
	1986	6290	59	200	63	17583	1848
United Arab Emirates	1981	250	87	-	-	20000	2400
	1986	800	69	-	-	24000	1583
Yemen	1981	145	42	29	36	305	2184
	1986	160	44	30	37	1000	1600

Note: Import values are CIF (cost + insurance + freight).

Table 3. Current retial prices (1987) of slaughter stock and meat (USD/kg) in selected countries.

Country	Cattle			Sheep and goats		
	Live animal	Prime-grade fresh meat	Frozen meat	Live animal	Prime-grade fresh meat	Frozen meat
Egypt	1.3-1.5	3.0-3.5	1.75	1.5-1.7	3.5-4.0	2.0
Iraq	6.0	10-13	3.0	6.0-7.0	12-15	3.5
Kuwait and Saudi Arabia	3.0-4.0	7.0-8.0	3.0	4.0-5.0	8-10	3.0
Oman	4.0	8.0-10.0	4.0	5.0-7.0	9-12	3.0
United Arab Emirates	1.3-2.0	3.0-4.5	2.0-2.5	1.5-3.5	3.5-5.5	2.0-2.5
Yemen	3.0-3.5	8-10	5.0	4.0-5.0	10-12	5.0

Goats also fall into this category, regardless of their origin. The next category comprises fresh meat from buffaloes and old cattle. Frozen beef or mutton and goat meat are the cheapest meats on the market and their consumption is gradually increasing.

Retail prices in Dubai are a good indication of the market for goats from Asia. Live goats imported from India are sold at USD 45–95 per head. The wide range reflects the variability in the weight and age of the imported goats. Somali goats fetch a lower price from USD 40 to 70. Goats imported from Turkey have a price range of USD 60–100 per head. However, fresh goat meat is sold at about the same price regardless of origin. Differences in the price of fresh meat depend largely on the cut and fleshiness of the carcass. Mutton with a visible fat tail carry the highest price tag. Frozen goat meat is about half the price of fresh goat meat.

The fat tail identifies local sheep, although the preference is generally for lean meat. The local sheep and those from Turkey, Sudan, and Somalia are preferred because of their taste, flavour, and tenderness. However, there is an increasing consumption of lean cuts of chilled or frozen beef and mutton. This is probably because of the increasing influence of western tastes and the result of advertising by Australian exporters. The fast-developing restaurant and catering business is another reason for the increased demand for lean, frozen meat. Asian goat meat fits into this trend well.

An important characteristic of the Middle East market is its intense competitiveness. Australian exporters are highly organized and have a strong program for export promotion. The basic element of export promotion is direct contact with local importers who are usually influential. Importing companies take different forms in different countries. There are state organizations in Egypt, Iran, and Iraq and private companies in the Persian Gulf countries. Some of the Gulf importers are large companies integrating land and sea transport, cold storage, and, sometimes, feedlots. The importers are quality conscious, although competitive prices are their primary consideration.

In recent years, Turkish and Indian exporters have been able to increase their exports to the Gulf countries. Indian exporters of frozen meat have arranged cold stores in the United Arab Emirates, from where they distribute frozen buffalo, mutton, and goat meat to all countries on the Arabian Peninsula, including Saudi Arabia. This arrangement and the relatively short shipping distance makes India very flexible and competitive in this area. Large quantities of both fresh and frozen meat are also reexported to Gulf countries from Kuwait.

Seasonality of imports is another characteristic of the Near East market, the high season being the month of Ramadhan and the Hajj. The Hajj season is not limited to Saudi Arabia, although the demand for slaughter at Mecca during the three Hajj days is large, i.e., about 2 million sheep and goats. These animals must be entire males without blemishes. Meat imports for Ramadhan are greatly increased in most countries of the Middle East. There is also seasonality of imports because of production cycles in exporting countries. Sheep from Australia and South America are imported primarily from January to May. Sheep from Bulgaria, Romania, and other European countries are imported from July to December.

Trade requirements

The requirements for exporting live goats or goat meat to the Middle East are not just regulatory in nature. They also involve the requirements imposed by the importer, i.e., those relating to quality, prices, punctuality of delivery, etc. The basic regulatory requirements for meat imports are the "Halal" slaughter and the fitness for human consumption certificate. For live animals, the zoosanitary requirements are the primary regulatory consideration and these are often the main bottlenecks in expanding Asian exports. Zoosanitary requirements for livestock and meat trade in the Near East are becoming more and more stringent.

To promote trade, it is the primary responsibility of the governments of exporting countries to take appropriate steps to minimize the possibility of disease transmission through the animals and meat exports. An important prerequisite is that the veterinary services be brought up to a standard where they would be fully effective. Partial measures of veterinary control of exports are often totally ineffective. The requirements for effective disease control in trade animals (vaccination and certification, quarantines, and veterinary control of animal and meat movements) should be efficiently implemented. Incomplete measures and halfway investments in disease control create problem.

The Office International des Epizooties (OIE) Zoosanitary Code provides rules and guidelines covering the interterritorial movement of animals and animal products. Various options are open to the countries concerned, depending on the disease state in these territories. Incubation periods are given for the diseases, and the diseases are categorized into three lists of graded significance. Certification is considered to be an important subject and guidelines are given on this. For goats and goat meat, the zoosanitary requirements are manageable as far as Asian exporters are concerned.

Bilateral agreements on zoosanitary requirements between importing and exporting countries are of fundamental importance. These can cover areas larger than one territory and can be worked on a regional basis. A good example is the bilateral agreement between Ethiopia and Egypt. Direct cooperation among traders of the importing and exporting countries could benefit the system and themselves. Such cooperation should be linked with cooperation among the veterinary authorities of these countries. Regional and international organizations have a role to play in promoting intercountry cooperation in improving the standards of health in trade animals and meat. This role could only be of coordination and advice rather than of inspection and control.

Transport requirements for live goats and for meat are determined not only by regulations of port of entry but also by the need for timely delivery and to safeguard the quality of meat and animals transported. Various combinations of modes of transport, i.e., trekking, road, rail, air, and sea, are being used to deliver goats to the Near East markets. The use of air freight for high-value chilled meat is on the increase. For Asian exporters, it is necessary that the total transport chain is fully planned and supervised at each stage. The economics and dependability should, however, govern such planning.

The competitiveness in the Near East market dictates the requirements of modern export marketing for infrastructure as well as for business efficiency. Asian and African exporters face a number of obstacles in developing sustained export trade. The FAO workshop on meat trade (FAO 1985) identified a number of structural factors concerning imports. Transport problems, cumbersome

bureaucratic procedures, overvalued controlled currency exchange rates, lack of market information, export financing, and payment problems were identified as some of the difficulties in establishing or expanding export trade. There is also a mass of documents required for the sale of animals throughout the many stages of sales from exporter to importer. The administrative requirements for a letter of credit can also be formidable in some countries (e.g. Egypt).

Export opportunities for Asia

Asia's share in the Near East meat trade is small. With the possible exception of India, the contribution of other Asian countries is negligible. Importing countries have expressed interest in expanding trade with developing countries despite the fierce competition in their markets among exporters with developed marketing infrastructure (FAO 1985). The potential does exist for developing additional sources of supply (FAO 1985).

As far as goats are concerned, Somalia and Turkey are currently the major exporters to the Near East (Table 4). Australia and New Zealand also have sizeable exports of goat meat. Demand for the importation of live goats and goat meat, in chilled or frozen form, however, remains unsaturated. Furthermore, there are opportunities of substituting mutton with goat meat. The present trend toward preferring lean meat favours goats. The zoosanitary requirements for goats and goat meat in many importing countries are also manageable as far as Asian exports are concerned. The proximity to the Middle East is another advantage.

Apart from the Near East, some Asian countries could also be considered potential importers of goats and goat meat. The import of mutton and goat meat is increasing in many Asian countries (Table 5). The share of sheep and goats in the total red meat import market in Asia is also increasing (Table 6). This is in contrast to the Near East, where the share of beef imports is rising, especially in Egypt, Iraq, and Saudi Arabia (Table 1). The recent availability of cheap European Economic Community surplus beef in the Near East is the primary cause of this sharp rise in beef imports.

Table 4. Exports of sheep and goats and their meat from selected countries.

		Live sheep		Live goats		Mutton		Goat meat	
Country	Year	Head ($x10^3$)	USD/head	Head ($x10^3$)	USD/head	t	USD/t	t	USD/t
Australia	1981	5740	34	-	-	242583	1512	-	-
	1986	6368	19	-	-	143997	1062	4357	1199
New Zealand	1981	21	87	-	-	494247	1633	847	1625
	1986	149	24	-	-	448661	1126	405	1336
Somalia	1981	700	69	786	71	-	-	-	-
	1986	570	58	550	53	-	-	-	-
Sudan	1981	495	82	4	34	7	3286	-	-
	1986	350	103	-	-	-	-	-	-
Turkey	1981	1608	116	310	80	24713	3083	2	1000
	1986	2583	80	385	52	35254	1773	102	2020

Note: Export values are FOB (free-on-board).

Table 5. Imports of sheep and their meats in Asia.

Country	Year	Live sheep		Live goats		Mutton		Goat meat	
		Head ($x10^3$)	USD/head	Head ($x10^3$)	USD/head	t	USD/t	t	USD/t
China	1981	-	-	-	-	600	1500	-	-
	1986	-	-	-	-	1100	818	-	-
Fiji	1981	-	-	-	-	3832	1596	236	2042
	1986	-	-	-	-	6800	1029	-	-
Hong Kong	1981	-	-	16	43	2473	3181	1347	4113
	1986	3	27	17	25	2911	2069	1522	2153
Malaysia	1981	4	111	-	-	3249	1653	-	-
	1986	5	80	-	-	6000	1500	-	-
Mauritius	1981	-	-	-	-	1596	1731	-	-
	1986	-	-	-	-	2667	1045	133	1015
Philippines	1981	-	-	-	-	61	4246	-	-
	1986	-	-	-	-	20	6150	-	-
Republic of Korea	1981	-	-	-	-	10577	1090	-	-
	1986	-	-	-	-	13577	814	-	-
Singapore	1981	63	59	-	-	5250	1842	-	-
	1986	61	46	1	48	6170	1145	-	-
Taiwan	1981	-	-	-	-	4069	1771	-	-
	1986	-	-	-	-	10100	979	-	-

Note: Export values are CIF (cost + insurance + freight).

Table 6. Share of cattle, sheep and goats (%) in the total value of red meat and live animal imports.

Region	Meat			Live animals		
	Cattle	Sheep	Goats	Cattle	Sheep	Goats
Near East						
1981	48.7	51.3	0	25.3	73.3	1.4
1986	61.3	38.7	0	23.5	74.7	1.8
Asia						
1981	65.2	30.0	4.8	94.4	4.0	1.6
1986	25.8	67.7	6.5	87.6	7.3	5.1

[a]Near East and Asia include all countries of the respective regions.

Concerning the export of goat products, goat skin is a valuable commodity. There is a large international demand for salted or tanned goat skins. Indonesia, for example, exported 2715 t of wet-salted goat skins in 1985 valued at USD 5330/t. This volume had remained stagnant for many years. The main problem in marketing of goat skins is collecting high-quality skins with minimum blemishes. With improve-ments in flaying and in the skin-marketing system, an appreciable value would be added to the slaughter stock (Sandford 1982).

The crucial element of the marketing system within the exporting country is the collection of the required slaughter stock at the export point or at the export abattoir (Fig. 1). The existing marketing channels appear to lead toward such

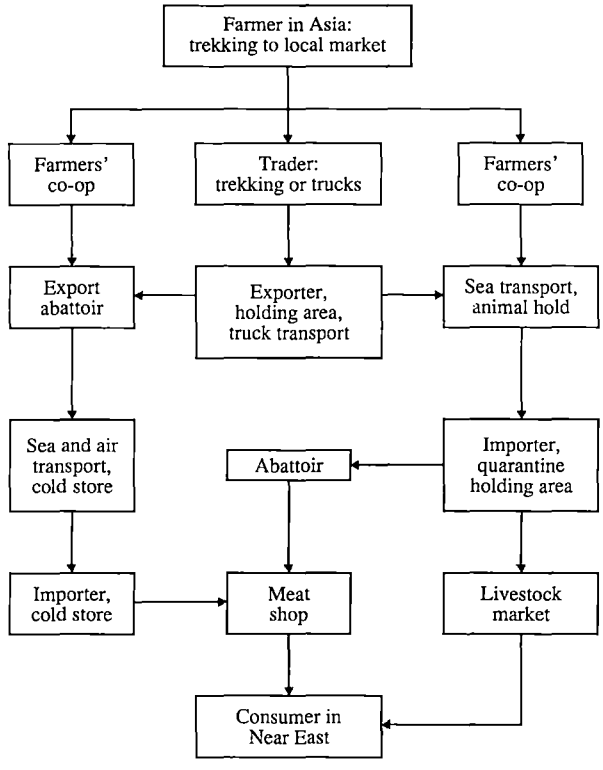

Fig. 1. Channels for marketing Asian goats in the Near East.

points whenever a buyer is within reach of a producer and the price is right. Sandford (1982) argues that the traditional marketing systems tend to be more effective for goats in the dry regions. Mittel (1984) reports that the arid tract of Rajasthan is currently the major supplier of goats for the modern abattoir at Deonar, Bombay. Reusse (1982) describes the organization of livestock trekking in Somalia toward an export point. However, the export of meat may be a more practicable proposition than moving goats on hoof, which is a difficult operation to manage compared with moving sheep or cattle.

The establishment of intensified systems of goat meat production and marketing systems that integrate transport, slaughter, and export would facilitate exportation of live animals or meat of the required quality. Experience in Africa suggests that instituting governmental or parastatal monopolies is not the best way of bringing about such developments. It appears that farmer cooperatives would play an important role in collecting goats for export on a regular basis. The cooperatives may also integrate a series of marketing channels including abattoirs, cold storage, and meat transport. The cooperatives may also establish joint ventures with importers in some countries.

The marketing costs should not be too high to take advantage of the higher meat prices in the Near East markets. Exports should also increase the price paid to the producer. Only through increases in market prices will producers increase

their supply (Fenn 1977). Increased prices could also stimulate intensified production systems. Such systems, including fattening or finishing operations, will also reduce seasonality and ensure a year-round supply.

There are also important policy considerations in promoting the export of goat meat. These must ensure adequate domestic availability of goat meat, especially in the rural areas, while exploring export opportunities. In addition, the cost of exportation and meat prices at home may sometimes favour domestic sales. Government policy must determine the relative importance of earning foreign exchange through export of commodities such as goat meat.

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By-products from goat meat production and their marketing in India

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Abstract: *India, with 95 million goats (1982), annually produces 69 million goat skins and an equal amount of intestines through slaughter. Through a wide network of marketing systems, the goat skins are mobilized and converted into different end products. The value addition in processing reaches 350% and provides substantial employment. The Government of India has provided the necessary policy backup for stimulating processing activity and for promoting exports of goat skins as leathers and leather products. The goat skin based leathers and leather products claim 45% of the country's leather exports. The bulk of intestines is used in edible products (e.g., sausage casings) because of the high price of meat; the balance is used for cat guts and, to a small extent, sports guts. Sausage casings and cat guts are exported. Blood is another item used in edible products. The future seems bright for the enhanced production of by-products and their industrial exploitation for which necessary development programs and policies are now being contemplated by the Government of India.*

Résumé: *En Inde, dont le cheptel caprin est de 95 millions de têtes (1982), les abattoirs produisent chaque année 69 millions de peaux de chèvre et une quantité égale d'intestins. Le vaste réseau de systèmes de commercialisation permet la transformation de ces peaux de chèvre en différents produits. L'augmentation de leur valeur atteint les 350 % et représente une source d'emploi substantielle. Le gouvernement de l'Inde a fourni l'appui politique nécessaire pour stimuler l'industrie de la transformation et promouvoir les exportations de peaux de chèvre (cuir et de produits en cuir) lesquelles représentent 45 % des exportations de cuir du pays. Quant aux intestins, ils sont employés dans les produits comestibles (p. ex., comme boyaux pour la saucisse) en raison du prix élevé de la viande; le reste est utilisé dans la fabrication de cordes de boyau et, dans une faible mesure, de cordes de raquettes. Les boyaux pour la saucisse et les cordes de boyau sont deux produits d'exportation. Le sang est lui aussi utilisé dans la fabrication de produits comestibles. L'avenir semble brillant pour la fabrication accrue de sous-produits tirés de la chèvre. Le gouvernement de l'Inde envisage actuellement l'adoption de programmes et de politiques en vue de leur exploitation industrielle.*

Resumen: *India, con 95 millones de cabras (1982) produce anualmente 69 millones de pieles de cabras y una cantidad igual de intestinos producto del sacrificio. A través de una amplia red de sistemas de comercialización, las pieles de cabras se convierten en diferentes productos finales. El valor adicionado en el procesamiento alcanza el 350% y provee empleos substanciales. El gobierno de la India ha proporcionado el apoyo necesario a la política para estimular la actividad de procesamiento y para promover las exportaciones de pieles de cabra como pieles y productos de cuero. Las pieles y productos de cuero que se fabrican a partir de la piel de cabra constituyen el 45% de las exportaciones de piel del país. El grueso de los intestinos se utiliza en productos comestibles (por ejamplo tripas para salchidas) debido al alto precio de la carne; el resto del producto se utiliza para la fabricación de cuerdas en general y, en menor escala, cuerdas de tripa para equipos deportivos. Las tripas de salchichas y las cuerdas se exportan. La sangre es otro elemento que se utiliza en productos comestibles. El futuro parace prometedor para un aumento en la producción de subproductos y su explotación industrial, para lo cual el gobierno indio está contemplando actualmente políticas y programas necesarios para su explotación industrial.*

With 95 million goats, accounting for 20% of the world stock, India has the largest goat population in the world (1982). According to Gopalakrishnan (1981),

goats in India contributed 0.25×10^6 t meat, 0.7×10^6 t milk, more than 60×10^6 pieces of skin, 300 t hair, and an enormous quantity of dung in 1981. Between 1961 and 1982, the goat population showed an annual growth rate of 2.7% in contrast to 0.9% for sheep, 0.5% for cattle, and 1.7% for buffalo (Seshagiri Rao 1987). Its higher reproductive rate and its adaptability to different types of feed and management give goats an advantage over other livestock species in terms of economic importance at the farm level. If the same trend of growth continues, the goat population will reach 145 million by the year 2002 and its share of the combined goat and sheep stock would rise from 66.5% in 1982 to 72.3% in 2002 (Seshagiri Rao 1987). In terms of availability of animals per 1000 humans, goat is the only species that has shown a positive growth (131 to 136) between 1951 and 1982; the availability of other species has dropped significantly: sheep, 108 to 69; cattle, 430 to 278; buffalo, 120 to 100. Clearly, the goat population is continuing to grow and will maintain its position as a major source of meat in India for years to come.

In recent years, on account of drought in several parts of India as well as a dwindling meat animal supply, the price of goat meat has increased considerably. Between 1977 and 1987, goat meat prices increased fourfold; cereals and pulses during the same period increased twofold in the Madras market. Both the average meat yield and the average skin area from goat slaughter have declined (CLRI 1987). This indicates that underage animals are being slaughtered prematurely in large numbers because of the inelastic supply of animals and the high demand for meat. To avert this situation, policies should be introduced to curb the slaughter of underage, productive, and seed stock; simultaneously, the meat animal stock should also be improved through systematic goat-farming programs. The 10.9% mortality among goats because of disease could be reduced through better medical care. The size of the stock, their growth trends, and the magnitude of slaughter are some factors that have a significant effect on the production of meat as well as the various by-products such as skins, blood, and intestines.

Realization from goat slaughter

Skins, intestines, and blood are the three major by-products, accounting for 14.4% of the total value realized from the slaughter of a goat (Table 1). Skins are exclusively used in the manufacture of various types of leathers, which, in turn, are converted into consumer products such as shoes, gloves, and handbags. A substantial proportion of the intestines is used in edible products and sausage casings; the balance is used to produce surgical guts and, to a small extent, sports and musical

Table 1. Products from the slaughter of a goat with an expected carcass weight of 10 kg in an urban slaughterhouse.

Product	Value (INR)[a]	% of total
Meat	360	78.3
Skin	55	12.2
Liver	14	3.0
Head and legs	20	4.3
Stomach	8	
Blood	2	2.4
Intestine	1	

[a]In March 1988, 12.2 Indian rupees (INR) = United States dollar (USD).

guts. Blood is partially recovered in some areas; otherwise, all the blood is allowed to drain away. The other products (head, legs, and liver) are edible items. Theoretically, it is possible to recover and process items like bile liquid, horns, hooves, and ruminal contents; however, on a commercial scale, these products are not being recovered because of various constraints such as limited availability, collection problems, and limited demand.

Production of goat skins

Because of the religious inhibitions on the consumption of beef among Hindus and the consumption of pork among Muslims, India depends largely on goats and sheep. Goat meat production accounted for 30.4% of the total meat produced in 1985 (ECMI 1987). Furthermore, India has the highest slaughter rate of goat in the world (67.9%). According to a recent survey (CLRI 1987), about 69 million goats were slaughtered in 1986; 50% were slaughtered in urban areas and 50% were slaughtered in villages throughout the country. As far as goat skins are concerned, their recovery is almost complete. Through a network of collection systems, the skins are mobilized from distant rural areas, semiurban areas, and urban centres to various markets in the country from where they are dispatched to different tanning centres. There are seven important terminal markets for goat skins operating in India, with an annual turnover ranging from 1 million to 12 million pieces; another 15 markets have annual turnovers ranging from 0.5 million to 1.0 million skins (Table 2). In addition, there are several markets operating below 0.5 million pieces/year throughout the country at regional and subregional levels.

Table 2. Important terminal markets for raw goat skins.

Market	Annual turnover[a]
Calcutta (West Bengal)	12.0
Delhi	7.2
Chenganancherri (Kerala)	3.7
Bombay (Maharashtra)	3.5
Kanpur (Uttar Pradesh)	2.9
Hyderabad (Andhra Pradesh)	2.5
Solapur (Maharashtra)	1.3
Ahmedabad (Gujarat)	0.9
Yedsi (Maharashtra)	0.8
Jaipur (Rajasthan)	0.8
Faizabad (Uttar Pradesh)	0.8
Madras (Tamil Nadu)	0.8
Lucknow (Uttar Pradesh)	0.7
Surat (Gujarat)	0.7
Amritsar (Punjab)	0.7
Gauhati (Assam)	0.7
Vijayawada (Andhra Pradesh)	0.6
Muzafarpur (Bihar)	0.6
Darbhanga (Bihar)	0.6
Guntur (Andhra Pradesh)	0.6
Chauri-Chaura (Uttar Pradesh)	0.5
Patna (Bihar)	0.5

Source: CLRI (1987).
[a]Millions of pieces.

Preservation

Skins are cured to prevent them from decaying before tanning. For this purpose, wet salting of the slaughtered skins is widely practiced. Depending on the duration of storage and the season, further saltings are given at different points in the market chain. Skins produced in the Himalayan region are flint dried because of the problems of salt transportation and storage. The proposition of such skins, however, is limited.

Production to processing

The duration between the procurement and the processing of the skins depends on season, distance, length of market chain, hoarding practices, etc. In general, the time lag is longest in the winter and shortest in the summer. Skins procured in urban centres are transported within 2 weeks to the tanneries. With skins from rural areas, the time lag may reach 2 months depending on the distance and number of stages involved in the market chain.

Price markup

In the market network, many middlemen are involved in the collection, preservation, transportation, and trading of goat skins. At each point in the chain, the skin gains additional value depending upon the inputs, storage period, and margin of profit to the seller.

The longer the chain, the higher is the ultimate price markup over the basic procurement price. With respect to the slaughtered skins from urban centres, the role of the middlemen is limited and the primary producer gets a fair price; the rural producer, however, being ignorant of prevailing market prices, remains in a disadvantageous position. In addition, the habit of accepting payment in advance cripples the bargaining power of the primary producer. The price markup of goat skins at the tanners' stage can reach 45% over the price originally paid to the primary producer at the village (CLRI 1987). This price markup varies from market to market and depends on the number of middlemen involved.

With the structural changes taking place in the leather industry with the establishment of more finishing units and the growing export trade, the raw material market structure is undergoing improvements. The market chain is becoming shorter and the role of the middlemen is gradually reducing. In certain terminal markets, the raw hide and skin dealers now convert raw materials into semitanned leathers and sell them to the finishing units. Some of the leading tanners have opened direct procurement centres in various markets. All these developments have changed the market structure to the benefit of both the producers and the consumers.

Value addition at different stages of processing

Enjoying low-cost labour, favourable licencing policies for setting up production units, and export incentives, since 1974 the Indian leather industry has established many processing and finishing centres in selected areas of Tamil Nadu, Uttar Pradesh, West Bengal, and, to some extent, Maharashtra. The value addition that accrues at different stages of processing and conversion is as follows (raw materials = 100): vegetable-tanned and chrome-tanned leathers, 150; finished leathers, 225; leather products, 450. The important tanning materials for vegetable tanned leathers are wattle, avaram, and myrobalan nuts and babul bark.

For many years, these leathers have enjoyed an international reputation for their quality, colour, and other properties. Similarly, unfinished chrome-tanned leathers produced mainly in West Bengal, Uttar Pradesh, Maharashtra, and Tamil Nadu are marketed mostly in East Europe.

Both vegetable-tanned and chrome-tanned unfinished leathers were produced mostly for export until export regulations were introduced in 1974. An export duty of 25% on the free-on-board value and quota restrictions were introduced to phase out these exports. Simultane-ously, a package of export incentives on finished leathers and products was introduced. Encouraged by these incentive programs, both horizontal and vertical expansion of the finished leather sector and leather products sector took place. Entrepreneurs from other industries and technocrats entered into this field. The necessary research and development inputs and technical know-how have been provided by concerned institutions. The important goat skin based products that are now exported include glaced-kid glove leathers, soft leathers, footwear uppers, and high value added fancy goods (e.g., ladies handbags, garments, gloves, etc.). As a result, the value of exports of goat skins and their products have gone up from INR 973×10^6 in 1973–74 (40×10^6 pieces) to INR 3000×10^6 in 1985–86 (50×10^6 pieces) (CLRI 1974). In 1985/86, goat skins and derived products accounted for 45% of India's total exports of leather and allied products (CLE 1987). About 66% of the total production of goat skins is now exported in some form. In 1985/86, 95% of the total export earnings from goat skins represented finished leathers and products; in 1973/74, these products accounted for 11%. These changes in the export structure more or less reflect corresponding changes in favour of industrial development that have taken place in the processing sector based on goat skins.

Blood

Blood accounts for 3.5–5.5% of the body weight of the animal. It is rich in protein and iron and, for this reason, blood is sometimes obtained from the slaughtered animal and used for consumption. On average, raw blood contains 80% water and 20% solids. In conventional slaughtering, the animal falls to the ground and the throat is then slit. In India, most slaughterhouses are not well equipped for the collection of blood. In addition, religious sentiments against the collection of blood are prevalent. As a result, the blood is either entirely lost or only a portion is collected. The hasty slaughter and growing congestion in slaughterhouses further inhibits effective blood collection. As a result, only 30–40% of the blood is being recovered from the slaughterhouses (CLRI 1987). The blood collected is used for consumption; in rural areas, this is quite popular. Muslims do not collect or utilize blood.

With the anticipated modernization of slaughterhouses in the urban centres and with the establishment of viable rural slaughtering in the years to come, blood collection is expected to improve. Proven technologies are available in India for the conversion of blood into valuable blood albumin, serum, and plasma, provided clean environment facilities for refrigeration are present in the slaughterhouses. Blood mixed with wheat bran or with treated "ruminal contents" (blood meal) is used as an animal feed supplement. Mixing blood with a less fibrous bran is more desirable for poultry feed than mixing with dried ruminal contents.

Bile

Bile liquid is another by-product that can be collected from goat (20–50 mL/animal). Muralidhara Rao (1986) observed that it is quite simple to convert the bile liquid into a paste that can be preserved. From this paste, cholic acid can be derived. In India, however, the recovery of bile in commercial slaughterhouses is not economically feasible because of the hasty slaughter and handling of the carcasses.

Intestines

Although India has a strong potential base with 69 million intestines from slaughtered goats in 1986, their recovery for the manufacture of specialty items (e.g., sausage casings, surgical guts, etc.) is limited for the following reasons:

- 50% of the total goat slaughter occurs in urban areas;
- Not all slaughterhouses in the urban centres are equipped with facilities necessary for the hygienic recovery of by-products;
- With the rising prices of meat, the diversion of intestines for consumption (along with the meat) is increasing;
- The butcher gets a better price if the intestine is sold for consumption, irrespective of quality;
- For sausage casings or conversion to cat guts or sports guts, intestines with a specific diameter and length are preferred;
- The overseas demand for Indian wet-salted casings is stagnant; and
- Special skills are necessary for processing intestines into value-added products.

In India, only in the urban centres, where sizeable production is occurring, is intestine processing continuing. To make casings, several operations such as pulling, strapping, fermentation, slimming, and scrapping are necessary (Mahendra Kumar 1981). Wet salting is performed using fine salt and rubbing it liberally on the rings and hanks. The salted casing is kept in a wooden bin with a perforated bottom, permitting the drainage of brine. Salting is considered complete when the formation of brine ceases. This may take 2 or 3 days. An improved process was developed by the Central Leather Research Institute to produce "dry ready to wet casings" free of fats and other unwanted appendages. With this process, white, light casings that can be stored for any length of time without deterioration can be obtained. These improved casings are suitable for dry filling, which facilitates wetting for sausage-making. The Central Leather Research Institute also developed technology for converting intestines into surgical cat guts. This technology has been transferred to industry. It is estimated that the annual value of cat gut production using this technology could be INR 12×10^6; this is a significant increase over the present annual cat gut production of INR 30×10^6. During 1984–85 about INR 40×10^6 worth of goat guts (for food casings) and INR 1.4×10^6 worth of surgical cat guts (from goat skin) were exported (CLRI 1985).

Intestines were used in the production of sports guts and musical strings. This industry is gradually dwindling, however, because of the substitutes emanating from nylon products and the high price of raw materials. A paucity of information

exists on the production of intestines in different regions, their categorization according to quality, the pattern of utilization, centres of processing, etc., and this hinders further analysis into the economics and marketing aspects of this material.

Conclusions

The importance of goat as a source of income to the farmer, a source of meat for human consumption, and a source of raw materials for the leather industry is increasing in India. Alternative models for developing goat under different systems of farming are being tried to evaluate their technoeconomic efficiency. In India today, hygienic meat production and meat handling systems are becoming important.

Attempts are being made to set up modern slaughterhouses in urban centres to ensure better handling of meat production and to recover slaughterhouse by-products under hygienic conditions. Like milk production and distribution, it may be possible to set up viable, rural, small, modern slaughterhouses and distribute the meat both in urban and rural centres. This model of development has the definite advantage of retaining the skin, blood, intestines, and ruminal contents in the rural areas and processing them close to the slaughterhouses without resorting to preservatives, etc. Apart from providing rural employment, this model avoids the use of salt, which becomes a pollutant in the process downstream of the by-product.

Export policies have been streamlined to encourage the export of high value added leather products and discourage the export of other less value added items. Thus, if the present line of thinking about the development of the meat industry and the processing of by-products takes concrete action, substantial wealth can be recovered based on the exploitation of goat-based slaughter by-products. The knowledge of the present status of production and handling systems of by-products, however, is limited. The information gap could be filled through a systematic, nationwide, technoeconomic survey on the present status of slaughterhouses and the recovery and utilization of slaughterhouse by-products. This study should also enumerate the processing units engaged in casings and gut manufacture, their volume of production and marketing, and identification of problems and prospects for accelerating their growth. In the interest of the national economy, it is essential to have an overseas market survey to assess the export potential for the country's products. It will be to the mutual advantage of the countries having sizeable goat populations to exchange information on different aspects of processing and marketing by-products.

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By-products from goat meat production and their marketing in Pakistan

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Abstract: *This paper discusses the status of production and marketing of by-products from goat meat in Pakistan. Information on blood, body fats, bones, guts, and glands as by-products was obtained through surveys from scattered sources. Slaughterhouse by-products have gained economic importance because of scientific and industrial uses. Developed countries have paid great attention and care to meat industry by-products; however, Pakistan loses millions of rupees every year because of a lack of collection and processing of these by-products. Stock owners, flayers, butchers, and by-product dealers should be trained to adopt improved methods of collection, preservation, and transportation to bulk collection depots and consumer outlets. It is imperative for national scientists, researchers, and planners to improve slaughter facilities to control the unwarranted waste of these valuable products and substantially increase the financial return per animal.*

Résumé: *Le présent document se penche sur la production et la commercialisation des sous-produits de la viande caprine au Pakistan. Des enquêtes menées auprès de diverses sources, ont permis d'obtenir de l'information sur l'utilisation du sang, des matières grasses, des os, des boyaux et des glandes comme sous-produits. L'utilisation à des fins scientifiques et industrielles des sous-produits des abattoirs a augmenté leur importance économique. Les pays développés ont porté beaucoup d'attention et de soins aux sous-produits de l'industrie de la viande; néanmoins, le Pakistan perd chaque année des millions de roupies faute de les récupérer et les transformer. Les propriétaires de bétail, les écorcheurs, les bouchers et les vendeurs de sous-produits devraient être formés à de meilleures méthodes de récolte, de conservation et de transport jusqu'aux entrepôts et aux points de vente des peaux. Il est impérieux que les scientifiques, les chercheurs et les planificateurs du pays améliorent les installations d'abattage pour prévenir la perte injustifiée de ces produits de valeur et accroître substantiellement la rentabilité de chaque animal.*

Resumen: *Ese trabajo discute la situación de la producción y comercialización de los subproductos de la carne de cabra en Paquistán. La información acerca de la sangre, grasas del cuerpo, huesos, tripas y glándulas como subproductos, se obtuvo a través de encuestas de fuentes diversas. Los subproductos de los mataderos han ganado importancia económica debido a los usos científicos e industriales. Los países desarrollados han prestado una gran atención y cuidado a los subproductos de la industria de la carne; sin embargo, Paquistán pierde millones de rupias cada año debido a una falta de recolección y procesamiento de estos subproductos. Los ganaderos, desolladores, carniceros y los comerciantes de estos productos deben entrenarse para adoptar mejores métodos de recolección, preservación y ransporte hacia depósitos de acopio y hacia las instalaciones donde se venden al consumidor. Es imperativo para los científicos, investigadores y planificadores nacionales mejorar las instalaciones de los mataderos para controlar el gasto injustificado de estos valiosos productos e incrementar la ganancia que se obtiene de cada animal.*

Despite the large number of animals slaughtered in Pakistan for human consumption in and outside the slaughterhouses, the question of by-product utilization has not been considered important. Widely scattered slaughterings and unassessed demand have often been given as the main reasons for this neglect.

Consequently, organized marketing of slaughterhouse by-products has continued to suffer.

The manufacture of slaughterhouse by-products should be considered with a view to establishing an industry that can encourage domestic utilization and export. The demand for such by-products could be met by local production if the present waste was minimized. The by-products that could be manufactured from slaughterhouse waste would also generate large amounts of money and foreign exchange.

In both urban and rural areas, a large number of goats and other livestock are slaughtered for local consumption (Table 1). This has caused a large number of small slaughterhouses to be scattered over the country. The control and function of these establishments have been difficult. Data are incomplete and the problem of producing and marketing slaughterhouse by-products cannot be studied in depth. The problem could be solved by establishing a system of regional slaughterhouses at central points from where meat supplies could come. Such a system would create new problems such as the need for specially equipped transport. However, organized slaughter, collection, handling, and marketing of meat and by-products, inspection and grading of meat, and treatment of hides and skins, which are main export items, would be easier and more effective. Only a limited number of slaughterhouses now handle enough livestock to justify the operation of an efficient and suitable plant for the manufacture of useful by-products. Even in these establishments, vast improvements could be made.

The amount of offal available, including by-products, is governed by the number of goats slaughtered (shown in Table 1). The economic value of the slaughter process, public health interests, and slaughterhouse efficiency should be ensured through swift and hygienic disposal of surplus material. The development of slaughterhouse by-products provides a safe and ready means of disposing of surplus materials and, at the same time, yielding important products such as meat for humans, animal feeds, fertilizers, glue, tallow, and pharmaceutical raw materials.

At present, it is impossible to accurately assess the production and marketing of by-products and the marketing channels. However, some estimations can be made concerning production, demand, utilization, and marketing of the most important by-products from meat and, in particular, those of goat.

Blood

Production

Blood is the most important slaughterhouse by-product and can be used for a variety of purposes. The disposal of blood should be one of the first factors to consider in the design of a slaughterhouse. At present, only a few slaughterhouses in Pakistan are designed for easy and complete collection of blood in its pure form. In most slaughterhouses of Pakistan, blood is collected mixed with other waste from the drains. For this reason, it is difficult to estimate the exact quantity of blood available as a by-product from the slaughter of goats. However, rough estimates are presented in Table 2 of the usable quantity of blood by-product from goats and its share of the total production. The annual production of blood from the slaughter of goats is estimated on the basis of the number of goats slaughtered per year. On average, one goat yields 0.91 kg blood (Yaqub and Ahmad 1957).

Table 1. Goats slaughtered in the recognized slaughterhouses of Pakistan.

Year	Goats slaughtered ($x10^3$)[a]	Year	Goats slaughtered ($x10^3$)[a]
1975/76	2254.8	1981/82	2998.5 (2.9)
1976/77	2273.9 (0.8)	1982/83	3737.7 (24.7)
1977/78	2294.5 (0.9)	1983/84	3420.2 (-8.5)
1978/79	2325.5 (1.4)	1984/85	3372.2 (-1.4)
1979/80	2368.8 (1.9)	1985/86	5288.8 (56.8)
1980/81	2915.1 (23.1)		

[a]Values in parentheses represent the percent increase (or decrease) from the previous year.

Table 2. Annual production ($x10^3$ t) of animal blood in Pakistan.

Year	Total production[a]	Production from goats[b]
1971/72	14.2	1.38 (9.72)
1972/73	15.0	1.65 (11.00)
1973/74	16.0	1.83 (11.44)
1974/75	16.0	1.95 (12.19)
1975/76	17.1	2.00 (11.70)
1976/77	17.9	2.05 (11.45)
1977/78	18.8	2.07 (11.01)
1978/79	19.6	2.09 (10.66)
1979/80	20.5	2.15 (12.04)
1980/81	21.5	2.65 (14.11)
1981/82	22.5	2.72 (13.92)
1982/83	23.9	3.40 (16.59)
1983/84	25.5	3.11 (14.47)
1984/85	27.2	3.07 (13.64)
1985/86	29.6	4.81 (20.14)
1986/87[c]	31.0	5.17 (20.26)

[a]Source: Pakistan (1975, 1984, 1987).
[b]Values in parentheses represent the blood production from goats as a percentage of total production.
[c]July to March.

Demand

Animal blood is in great demand for two major uses in Pakistan. Primarily, it is required for the production of blood meal. Blood meal is the dried form of blood and is a highly nitrogenous product, with 85% albuminoids. Secondly, blood is used as fertilizer around rural slaughterhouses, where there is no organized system of blood collection. In urban slaughterhouses, where slaughtering is done on a larger scale, the blood is scraped, mixed with other slaughter wastes, and used for the preparation of blood meal. Blood can also be used for extraction of blood albumin, which is in great demand in the leather industry; 100 kg blood yields about 40 kg haemoglobin and 60 kg plasma, or 16 kg dried haemoglobin, 3.5 kg dried serum, and 3.5 kg wet fibrin (Zeigler 1954).

As a fertilizer, dried blood is a valuable source of organic nitrogen, with 14% nitrogen and 17% ammonia. The blood is scraped, left outside the rural slaughterhouses, and is sold with other garbage and organic waste to landowners by local sweepers at a price calculated per bullock cart. For small slaughterhouses, because of limited output, blood meal preparation is uneconomic. Blood meal is

prepared with the blood from larger, urban slaughterhouses. Blood meal is used in the manufacture of compounded feeds for the poultry industry.

Losses

No data exist on the extent of the loss of blood in slaughter-houses. Enquiries suggest that about 40% of the blood produced is wasted annually. It is impossible to separate the bloods of goats and sheep, species that are often slaughtered together.

Marketing

The blood of the animals is scraped by contractors who are given contracts by the municipal committees and corporations controlling the slaughterhouses. The blood is sold to the contractors at yearly auctions. These contractors either sell the mixed, scraped blood material to other contractors, who prepare blood meal, or they prepare the blood meal themselves and sell it by weight to the animal feed manufacturers.

Body fats

A large portion of body fat is not sold along with the meat. These fats are removed from the carcass and rendered for sale as prepared fat (Haq and Masud 1966).

Production

In 1986/87, 94.7 $\times$ 10^3 t of unrendered body fat was produced. This is valued at approximately PKR 77.20 million (in March 1988, 17.1 Pakistan rupees [PKR] = 1 United States dollar [USD]). The quantity from goats accounted for 4% of this total (Table 3). The production of edible fats was estimated on the basis of the

Table 3. Annual production (x10^3 t) of animal fat in Pakistan.

Year	Total production[a]	Production from goats[a]
1971/72	45.8	0.10 (0.22)
1972/73	47.2	0.12 (0.25)
1973/74	14.9	0.14 (0.94)
1974/75	52.2	0.15 (0.29)
1975/76	54.7	1.53 (2.08)
1976/77	57.2	1.55 (2.71)
1977/78	59.8	1.57 (2.63)
1978/79	62.5	1.60 (2.56)
1979/80	65.3	1.61 (2.47)
1980/81	68.3	1.98 (2.90)
1981/82	71.4	2.04 (2.86)
1982/83	74.7	2.54 (3.40)
1983/84	79.3	2.33 (2.94)
1984/85	84.1	2.29 (2.72)
1985/86	89.0	3.60 (4.04)
1986/87[c]	94.7	3.86 (4.08)

[a]Source: Pakistan (1975, 1984, 1987).
[b]Values in parentheses represent the fat production from goats as a percentage of total fat production.
[c]July to March.

number of goats slaughtered per annum and the average weight of fat removed per carcass. Available information and enquiries made showed that the average weight of fat removed from one goat is 0.68 kg. The production of such fats from dead animals is not considered in the calculation.

Demand

In general, body fats are used for the preparation of inedible products. Apart from soaps (e.g., milled soap, framed soap, chips, flakes, floating soap, washing powder, and soft soap), the fats are also used in the manufacture of products like glycerine and nitroglycerine. Because of the various uses of fats, the present supply (from all livestock) is lower than the demand. The exact deficit cannot be gauged because of inadequate data.

Losses

Body fats from dead animals remain uncollected; therefore, a large quantity of valuable material is being wasted. If the body fats from all carcasses at slaughter were collected, the present supply of fats could be increased.

Marketing

Detailed surveys conducted by Agricultural Marketing and Animal Husbandry departments suggest that there is no organized marketing system for the sale of body fats. The butchers directly sell this by-product to contractors, who sell it for various uses to industry.

Bones

Production

About 223×10^3 t of bones was produced in 1986/87. It is estimated that nearly 85% of bones comes from large animals, 12% from small ruminants, and 3% from other domestic animals (Haq and Masud 1966). Goats annually contribute 2–3% of total bone production (Table 4). The annual production of bones is estimated based on the annual slaughter of goats. On average, one goat yields 2.8 kg of bones (Haq and Masud 1966).

Demand

Bones, horns, and hoofs are in great demand locally and abroad. They are used for a variety of purposes: e.g., manufacture of bone meal as fertilizer for crops; preparation of animal and poultry feeds; and preparation of commercial products like gelatin, glue, foam for fire extinguishers, lubricating oils, glycerine, and charcoal for case-hardening steel or clarifying sugar. Long bones ("marrows" and "knuckles") and horns are used in making fancy goods like buttons, laid wooden articles, handles for swords and knives, jewelry, etc. As the chemical industry of Pakistan is generally underdeveloped, the demand for bones is restricted to exports. Even so, this demand is low because of the few bone-crushing mills and, to some extent, the lack of bone collection in rural areas (where this is not considered to be an honourable vocation). More bone industries are needed to further develop the export potential.

Table 4. Annual production ($x10^3$ t) of animal bones in Pakistan.

Year	Total production[a]	Production from goats[b]
1971/72	152	0.21 (0.14)
1972/73	157	0.24 (0.15)
1973/74	161	0.27 (0.17)
1974/75	166	0.49 (0.30)
1975/76	173	2.07 (1.27)
1976/77	177	2.30 (1.30)
1977/78	181	2.42 (1.34)
1978/79	185	2.95 (1.59)
1979/80	189	3.22 (1.70)
1980/81	194	3.96 (2.04)
1981/82	199	4.07 (2.05)
1982/83	203	5.08 (2.50)
1983/84	208	4.65 (2.24)
1984/85	213	4.59 (2.15)
1985/86	218	4.89 (3.30)
1986/87[c]	223	5.45 (2.44)

[a]Source: Pakistan (1975, 1984, 1987).
[b]Values in parentheses represent the bone production of goats as a percentage of total bone production.
[c]July to March.

Losses

From 65 to 80% of the annual production of bones remains uncollected. This waste is valued at around PKR 450 million. This is a great waste of valuable raw material that could be used in the manufacture of a variety of useful products. The contention that uncollected bones help to enrich arable soils is an erroneous view.

Marketing

All types of bones are collected, seasoned, and marketed in primary markets. In export markets, bones, horns, and hoofs are generally sold after crushing separately. Common forms of export include bone grit, bone meal, sinews, and horn or hoof meal. No distinction is made in the market about bones from different species.

Future development

Research should be undertaken to investigate the characteristics and composition of the various types of bones and their suitability for the manufacture of products like fertilizers, feeds, and industrial chemicals. Impetus should be given to the development of handicrafts from bones on a cottage scale. Such industries would augment income and provide decorative articles for the home and for export. The bone trade should be developed by stressing the necessity of collecting bones through publicity on their end uses, improving methods of seasoning and storage before dispatch to terminal markets (the employment of bone collectors by union councils merits attention), increasing the bone-crushing capacity of the mills, and establishing bone-product industries in suitable areas.

Guts

Production

Pakistan produced 5.11×10^6 pieces of guts in 1986/87 (Table 5). Of this total, large animals account for two thirds and small ruminants (sheep and goats) account for one third. The potential production of the intestines or guts was estimated from the number of animals slaughtered regularly in slaughterhouses. The guts actually collected were estimated on the basis of local enquiries. Guts from oxen, buffaloes, sheep, and goats killed for meat in urban areas are collected in all cases. In the rural areas, oxen guts are collected from 5% of the carcasses, buffalo guts are not collected at all, and sheep and goat guts are removed from 75% of the carcasses. The ratio of urban to rural slaughters is 2:1.

Demand

Guts are mainly used as casings for sausages and in goods like tennis rackets, musical instruments, and spinning wheels. The demand for the various types of guts from different industries has not been determined. Local enquiries suggest, however, that undamaged guts with a diameter of 18 mm or more obtained from the slaughter of sheep and goats, as well as some guts from larger animals, are exported in a wet-salted condition. Most of the gut supply is prepared for home use; some are exported as casings (Table 6).

Because of the demand for guts at home and in the international market, efforts to collect all available guts and set up other industries (e.g., canning guts from slaughtered animals for human consumption) to ensure an economic use of this valuable raw material are lucrative. To ensure the sale of good-quality guts, effective methods of collection, preservation, and transportation need to be devised.

Losses

Approximately 0.50×10^6 pieces of guts are lost every year; 0.35×10^6 because of noncollection and 0.15×10^6 as a result of damage (during the process of removal from the carcass) and spoilage (owing to putrefaction following imperfect preservation). Such losses are particularly observed with dead animals and with solitary slaughterings on festive occasions. It must be remembered that guts from dead animals are not condemnable in all cases, and that a considerable number of such guts can be collected and used for the manufacture of prepared guts or inedible commercial products.

Future development

The supply of guts should be increased by collecting a large number of pieces from slaughtered and dead carcasses. Collection and preservation centres at slaughterhouses and in villages can be useful in encouraging commercial value.

Stock owners, flayers, butchers, and gut dealers should be acquainted with the utility of this valuable material, the effective methods of removing guts from the carcass, and the proper methods of cleaning, preserving, and transporting the guts to the collection centres and consumers. In addition, arrangements should be

Table 5. Production ($x10^3$ t) of guts in Pakistan.

Year	Total production	Production from goats[a]
1971/72	20.0	0.14 (0.70)
1972/73	21.5	0.16 (0.74)
1973/74	23.0	0.18 (0.78)
1974/75	24.9	0.20 (0.80)
1975/76	26.4	2.03 (7.70)
1976/77	28.0	2.05 (7.32)
1977/78	31.0	2.11 (6.80)
1978/79	33.5	2.18 (6.50)
1979/80	35.2	2.23 (6.33)
1980/81	37.7	2.63 (7.00)
1981/82	40.3	2.70 (6.70)
1982/83	43.6	3.36 (7.70)
1983/84	44.8	3.08 (6.87)
1984/85	46.0	3.04 (6.60)
1985/86	47.3	4.76 (10.06)
1986/87	50.0	5.11 (10.22)

[a]Values in parentheses represent the gut production of goats as a percentage of total gut production.

Table 6. Annual export value and quantity of animal casing produced in Pakistan.

Year	Quantity ($x10^3$ kg)	Value ($x10^6$ PKR)	Unit value (PKR/kg)[a]
1969/70	296	15	50
1970/71	424	8	20
1971/72	248	10	38
1972/73	265	21	80
1973/74	489	29	60
1974/75	165	21	128
1975/76	256	35	137
1976/77	213	33	155
1977/78	182	26	145
1978/79	224	31	139
1979/80	231	41	314
1980/81	269	60	223
1981/82	270	57	210
1982/83	262	53	201
1983/84	287	56	195
1984/85	338	69	204
1985/86	482	99	205
1986/87	360	99	275

[a]In March 1988, 17.1 Pakistan rupees (PKR) = 1 United States dollar (USD).

made for the sale of graded casings and prepared gut, thereby ensuring organized sales and increased foreign exchange earnings.

Research organizations should conduct investigations on the following topics:

- New, profitable uses for the various types,
- Commercial products that can be prepared from guts unsuitable for sale as casings or prepared gut, and
- Possibilities of popularizing the sale of guts from slaughtered animals as human food in a suitable form, as is done in some countries.

Other products

Several parts of the carcass, notably the glands (for making glandular extracts), are not collected or used, mainly because the by-products of the meat industry have received little attention. Consequently, these products are imported at high prices and loss of foreign exchange. The collection and manufacture of these products along sound and economic lines merits attention.

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Discussion

The first paper of this final session summarized the economics of goat meat production. The presentation highlighted the need for more information on the contribution of goats to small farm income and sources of cash. The need for government policies to support programs that assist small farmers was also highlighted. Apparently, the demand for goat meat increases faster than income; however, it is unclear where exactly in Asia this occurred. Discussion centred on the difficulties in deciding which parameters to use in the economic analysis of input costs. Unlike economists, farmers may not consider labour as a cost; both situations must be analyzed. The need for better survey data of small farms and the inclusion of economists in multidisciplinary research teams investigating problems of small farms was pointed out and discussed. It was stressed that unless research results are communicated to the farmers, the research is of little value.

The second paper in this session summarized the marketing of goat meat. In India, there is an infrastructure of slaughterhouses, chillers, and freezers, goats account for one-third of meat production, and there is preshipment quality inspection at export points. The meat is mainly consumed 8–10 h after slaughter. The presentation highlighted the fact that, over a 10-year period, goat meat prices have risen significantly, but producers have gained very little. The main beneficiary of these price increases has been the middleman. Therefore, there has been no incentive to increase meat production. Discussion centred on why export prices have not risen as fast as local prices. This may be due to a relatively constant overseas market or the slower increase in export prices than in export costs. This situation needs to be investigated. It was also pointed out that primary-produce exporters must work together to fight growing tariff and nontariff barriers.

In the Near East, fat-tailed sheep and other imported sheep and goats are preferred, and the use of imported chilled and frozen beef and mutton is increasing. For countries with surplus meat, the Near East provides definite export opportunities. The trade requirements in this region, however, are quite specific and the required documentation is formidable. It is essential that the meat be hygienic and that any livestock for export be certified disease free. Such requirements demand that the exporting country have an effective and reliable veterinary certification system. At present, in Asia, only India is taking advantage of the Near East market. During the discussion it was suggested that marketing systems integrating transport, slaughter, and export could facilitate live exports. African experience suggests that producer cooperatives are better than government organizations for bringing about such developments. The following areas merit attention:

- The need for adequate domestic meat supplies,
- The cost of exporting versus local marketing, and
- Government policies on the value of earning foreign exchange versus the value of feeding the local population.

The fourth paper in this session discussed the by-products of goat meat production and their marketing in India. By-products account for 22% of the value of the goat. Skin collection from the urban and rural areas of India is well organized. The production of leather from skins is a good example of added value. Blood can be used as fertilizer or as a food. Intestines are mostly used in edible products. There is some export of processed intestines. The discussion centred around the feasibility of, after slaughter, retaining by-products and transporting meat.

In the final paper of this session, it was emphasized that Pakistan is not making the best use of goat by-products (blood meal, fats and bones), keeping in mind that about 16 million goats are slaughtered annually. Gut products and especially blood meal are largely wasted because of inefficient methods of collection, preservation, transportation, and grading. The producer is always at a disadvantage because of the lack of price controls and price information as well as the many charges from the farm to the producer. Leather exports are third in foreign exchange earnings in Pakistan; however, the specific roles of goat skin in this industry are still unclear. During the discussion it was agreed that there is considerable potential for increasing the recovery of by-products and utilizing the goat resource more efficiently.

Conclusions and Recommendations

The conclusions and recommendations of the workshop were the result of three working groups that addressed all aspects of meat production in goats. The participants were grouped according to discipline and specialization. The recommendations are categorized into quantitative, qualitative, and economic and marketing factors. It is emphasized that these sections should be integrated into a multidisciplinary research effort, including participation of farmers in whole-farm systems, on research and development programs concerned with economic meat production.

In particular, attention was drawn to the three prevailing ruminant production systems on the Asian region: extensive systems; systems combining arable cropping, of which there are two varieties, the roadside, communal, arable grazing, and tethering methods and the cut-and-carry (zero grazing) method; and systems integrated with tree cropping.

Current investments in research and development of goats in all Asian countries are low compared with other animals. The low investments are in any case more concerned with milk and fibre. This has, in turn, contributed to a sparse base of knowledge in various aspects of profitable goat production. In particular, most national programs have not given enough attention to goat meat production.

It is stressed that these recommendations were made in the context of the fact that Asia has about 45% of the world population of goats, producing 63% of the total output of world goat meat production. The following summary of the recommendations represents the overall consensus of the workshop in terms of the most important priority areas.

Quantitative factors

Breeding

The factors determining meat production are breed, age, growth, sex, weight, efficiency of feed conversion, carcass yield, age at first kidding, litter size at birth and weaning, milk yield of does, number of kiddings per year, and productive life span. Concerning the carcass, specific linear measurements (top of leg to crutch, length of tibia tarsus, and carcass length), cuts, and eye muscle area were considered important. In consideration of these, the working group made the following six recommendations.

First, there should be a more complete evaluation of the goat genetic resources. Research should focus on the evaluation of those indigenous breeds that are numerically more important and whose products match local consumer preferences. Such studies involve properly designed surveys of these breeds in their home environment to include the following: physical environment, feed resources, feeding and management practices, flock size and structure, body size, and conformation. The performance data should measure growth, milk production, survival, reproduction, diseases, adaptation characteristics, and major constraints to improvement. These studies should be supported by laboratory evaluation of gene-

marker characteristics related to cytological, immunological, and biochemical aspects to determine the genetic distances among breeds. In addition, many meat breeds also have good skins and their production also needs investigation.

The following 40 indigenous breeds of goats were considered important for meat production:

Country or region	Breeds[a]
Bangladesh	Black Bengal
China	Banjiao, Chengdu Ma, Du An, Fuquing, Guizhou White, Haimen, Huai, Leizhou, Longlin, Matou, Shanxi White
India	Barbari, Black Bengal, Cutchi, Ganjam, Khasi (Assam Hill goat), Malabari, Marwari, Osmanabadi, Sangamaneri, Sirohi (DP)
Nepal	Changra, Khari, Sinhal, Terai
Pakistan	Barbari (DP, "Barri"), Bangal (Teddy), Bugri, Chappar (DP), Damani, Jattan (DP), Kacchan (DP), Kaghani, Kail, Lehri, Patteri, Tapri
Sri Lanka	Kotukachchiya
Southeast Asia	Katjang

[a] DP, dual purpose.

Second, crossbreeding with indigenous breeds and exotic breeds for increased meat production should only be undertaken when proven necessary, including adaptability. The exotic breeds for this purpose include these from within and outside the region. Breed and breed comparisons should be carried out at experiment stations and on farms involving appropriate production systems that evaluate total productivity and economic values.

Third, the selection of breeding males for improving meat production in indigenous breeds (meat and dual-purpose types) should be based on body weight at 6 months. Litter size at birth and weaning are also important. In females, milk yield, aged at first kidding, number of kiddings per year, and litter size at birth should be considered.

Fourth, detailed studies on the effects of castration on the quantitative and qualitative aspects of goat products are urgently needed. Research on the methods of castration, the effects on tissue composition and carcass characteristics, and economic benefits is required.

Fifth, studies on the efficient production of good-quality skin are needed.

Sixth, breed improvement programs should preferably involve farmers' flocks. This can be done by identifying flocks conforming to the breed type and having better than average performance. Farmers could also be organized into group breeding schemes.

Feed resources and nutrition

Feed resources and nutrition was the subject of considerable discussion in the context of the fact that it was probably the most important factor affecting production. The workshop recognized the existence of a variety of crop residues, by-products, and nonconventional feeds, including a variety of shrubs and tree legumes suitable for feeding to goats. The influence of dietary variables (mainly energy and proteins) needs to be evaluated in relation to tissue growth and composition (bones, muscles, and fat), carcass characteristics, total edible and saleable proportions, and the economic value of the products. The discussion was varied, but the following points were considered worthy of increased focus.

Availability and nutritive value

It is essential to completely list and assess the various types of feeds available: forages, shrubs, tree leaves, crop residues, agroindustrial by-products (AIBP), and nonconventional feeds. Where information on nutritive value is inadequate, evaluation of those feeds, including determination of any toxic principles, is necessary.

The reference to available feed resources also touched on permanent tree crops (coconuts, oil palm, and rubber). The potential benefits of integrating goats with these crops and in wider agroforestry systems was stressed and considered a high-priority area for research and development. In many parts of Southeast Asia where feed is generally more plentiful, research into conservation methods appropriate for small farms is necessary. This applies to forages, tree leaves, and crop residues in a manner that can sustain a year-round feeding system.

Development of economic diets

The development of economic diets is essential to reduce the cost of feeds. Crop residues and AIBP (e.g., straws of rice, wheat, maize, and sorghum, bagasse, and corn cobs) are generally plentiful in many countries. These feeds need to be evaluated for palatability, intake, and availability of nutrients for adult goats. The development of diets must ensure nutrient balance by including minerals and vitamins. Feeding trials need to define the breed used, the level of feeding, the type of feeding system, and the pattern of utilization for tissue growth and meat production. The value of dietary formulations must be assessed in economic terms.

Feeding strategies

The following potentially valuable feeding strategies were recommended. First, large-scale utilization of crop residues and AIBP is necessary in intensive systems of management. This is a system that has been inadequately studied but one that has high economic potential. Second, feeds should be processed where appropriate for the development of economic feeding systems. Third, strategic use of protein supplements (e.g., cottonseed cake, coconut cake, and palm kernel cake) are necessary to ensure animal performance. The areas for research include the use of high-nitrogen materials, e.g., tree legumes and urea–molasses block licks.

Reproduction

Because indigenous goat breeds in the tropics exhibit estrous activity throughout the year, there is limited influence by the physical environment, especially changes in photoperiod. There may be peaks of breeding and kidding during

certain parts of the year mostly because of the influence of rainfall, increased fodder growth, and improved nutrition. The following recommendations were made by the group.

First, to increase numbers for meat production, goats should be rebred soon after kidding. This calls for efficient detection of estrous symptoms and the use of the selected bucks.

Second, there are large inter- and intra-breed differences in reproductive efficiency. Well-controlled studies are needed to assess the interaction between breed type and feeding management on the incidence of estrus, hormonal profiles, ovulation rates, conception, kidding percentage, kid growth, and survival. The possibility of introducing superior inheritance for reproductive efficiency through crossbreeding also needs examination.

Third, standardized and practical techniques are urgently required for the freezing of buck semen and the introduction of artificial insemination (AI) to maximize the use of superior bucks.

Fourth, recent developments in techniques for multiple ovulation and embryo-transfer technology suggest potential benefit in maximizing the rate of genetic gain through the use of selected animals. Standardization of the techniques and relative cost of application, however, will determine their use and relevance in Asian countries.

Health and diseases

The health and diseases of meat goats was discussed at length. Particular reference was made to the need to reduce neonatal and preweaning mortality.

The group made the following six recommendations.

- An epidemiological survey of goat diseases and diagnostic facilities in individual countries should be given high priority.
- Vaccines for important goat diseases (e.g., anthrax, rindapest, foot-and-mouth, goat pox, and hemorrhagic septicemia) should be routinely made available to all Asian countries.
- Research on the development of immunodiagnostic tools, particularly for the early diagnosis of Johne's disease, including its testing, as well as for *Brucellosis*, is necessary. Monoclonal antibodies against *Escherichia coli* are also required.
- Controlled measures for ectoparasites and gastrointestinal parasites should be routinely monitored in experimental and farmers flocks.
- A package of practices for rearing kids needs to be generated in individual countries to suit climatic conditions with special reference to colostrum feeding, application of probiotics and electrolytes, shelter hygiene, colibacillosis, pneumonia, and contagious caprine pleuropneumonia.
- Importation of exotic animals, semen, and embryos should meet prescribed standards that ensure freedom from exotic diseases, e.g., caprine arthritis encephalitis.

Qualitative factors

Consumer requirements

Consumer prices for meat are influenced by individual preferences and by the comparative prices of other classes of meat. For these reasons it is important for goat producers to appreciate consumer requirements in individual countries. In the long term, more goat meat will be sold if the preferred type of carcass is known, and there can be increased efficiency in goat meat production, including improved slaughter methods. Because health and hygiene are important in slaughter, these aspects should be improved. If meat is to be sold as a high-priced product, it must be treated appropriately. High prices for goat meat can only be justified with high standards of hygiene.

The working group made three general recommendations on consumer requirements.

- Studies are required to ascertain the differences in consumer preferences and requirements in Asian countries.
- Quality was defined as the product that the consumer most wants and is prepared to pay the highest price for. In some countries, all the meat on display was sold. Questions were raised about the value of a grading system at this stage in any country. The factors that influence retail prices need to be studied.
- In countries where there is a shortage of goat meat (e.g., Nepal and Malaysia), processing is unlikely and would have a low research priority. In others, such as the Philippines, where goat meat is apparently less acceptable, processing may be advantageous to encourage sales. Processing may also help with the sale of by-products from meat production.

Carcass characteristics

The group made two recommendation on carcass characteristics. First, studies are needed on the influence of age, sex, and live weight on the flavour and tenderness of the meat. Second, research is required on the availability and utilization of animal by-products.

Slaughterhouse systems

The location and development of slaughterhouse systems should be evaluated by economic and marketing specialists to enable more efficient and economic use of abattoir by-products. A good example is blood, which is potentially valuable as a fertilizer, animal feed, or even human food. Currently, blood is wasted and causes pollution problems. This aspect merits investigation.

There is also need for a study on slaughter methods, the possibility and cost of humane slaughter, and the use of dressing methods that minimize carcass contamination. This suggestion is meaningless unless postslaughter carcass-handling methods from the slaughterhouse to the marketplaces are also improved in the long term.

Studies are needed on the improvement of hygiene standards concerning the long-term storage of meat. Concern was expressed for excessive standards that are essentially nontariff barriers. The group also recommended the need for training butchers and meat inspectors.

Economics and Marketing

Economics Research and Development

The group recognized the importance of relating three prevailing ruminant production systems previously referred to concerning the economics of goat meat production. Given the considerable variability in agroclimatic zones and ecological considerations and conditions, the recommendations for appropriate technology should be made with care. The group made the following recommendations.

- Socioeconomic profiles that represent average conditions should be outlined and updated on a continuous basis for major goat meat production areas. Differences because of production systems should be noted.
- There is an urgent need to determine the carrying capacity of each type of production system on technical and economic grounds.
- The role of quantitative and flow models was recognized. Generalized input–output models should be developed for key areas.
- Studies should be conducted by technoeconomic groups to identify economic and financial aspects of goat meat production investments. These aspects should be compared with other opportunities available with similar resources.
- Important gaps and constraints in productivity should be identified through realistic, large-scale, on-farm research. These findings should become the basis for planning future research.
- Economic analysis of proposed technical interventions such as new breeds, forages, nutrition, medicines, and husbandry practices should become a routine aspect of research. Skills in the conduct of such analyses should be imparted to scientists directly involved in technology generation and transfer.
- The need to identify performance in economic terms was stressed. The group identified the following seven key indicators for evaluating new technology and proposals: feed efficiency and growth; mortality; kidding percentage/reproductive efficiency; dressing percentage; lifetime returns; labour utilization; and income contribution.
- Areas for high-priority research and extension benefits should be identified jointly by technical and social scientists. The role of the sociologist was recognized in determining these benefits.
- Economic analysis should be segmented and a framework developed for economic goat meat production in three types of countries: where goats have been established and large populations exist, where goats are being introduced and developed, and where goats are being imported and may become producers in the future.
- Careful evaluation is needed before promoting large-scale enterprises. The interests of landless farmers and smallholders should be taken into account.
- Input–output relationships for different breeds should be analyzed for both the experiment station and farm situations. The results should be updated on a regular basis and made available.
- Economic studies of consumer and producer preferences should be undertaken.

- Better methods of data collection must be developed. The group noted that the statistics in government reports was often inaccurate and misleading, resulting in controversy. It is strongly recommended that the methods of data collection and the sources be thoroughly checked.
- The case-study approach in comparing data between Asian countries is recommended. In this task, the standardization of performas is essential.
- An economic evaluation of various incentive schemes such as subsidies, taxation, government fees, and credit needs to be carried out. Banking institutions and government agencies can be involved in supporting this research.
- There is a need for better documentation and distribution of economic information.
- More information is required on nomadic systems, drought conditions, and the availability of forage. Monitoring drought conditions and forage is essential to enable the efficient utilization of the rangelands.
- Where needed, a feed-export policy on indigenous feed ingredients, keeping in mind needs of goat producers in individual countries, should be defined.

Marketing

The group made the following six recommendations in the area of goat meat marketing.

- Studies on marketing margins, the role of the middleman, and vertical and horizontal arrangements in the marketing of goat meat should be initiated.
- Aspects of losses, transportation, handling, and processing should be documented, including ways to improve their efficiency.
- The prevailing marketing systems and possible alternatives both within and between countries should be studied.
- It is recommended that animals be sold on a live-weight basis instead of on a unit basis.
- Prices are determined by market forces. Any change in price or policy decision should be made by economists in consultation with animal scientists.
- Marketing limitations, monopolies, oligopolies, and govern-ment intervention need to be examined, as do protection, emerging trends, and developments in international trade. These aspects should be communicated to other countries in the region.

Communication

The method of communicating information will differ with production system. Where possible, however, resource inventories that describe systems should be made widely available. Insurance opportunities also need to be communicated to the farmers. The importance of contact between researchers and farmers through on-farm research was stressed.

For the producers, it is important that the seasonality of meat demand, labour, and feeds be identified and communicated. In this respect, the use of mass media and audiovisual aids was stressed. The group also recommended the formation of a regular goat news bulletin focusing on Asia.

Training

Graduate training in goat production should be restricted to Asia, and the production systems studied should be as close as possible to the country conditions. Training in meat marketing and processing, however, should be pursued in more advanced countries. Graduate curricula on goat husbandry should be developed and revised.

Farmer training should involve direct participation that will allow sharing of experiences and serve as a training ground for students. There are opportunities for providing husbandry training to school-going children. Programs that are targeted at women will greatly benefit the stability of the farm household. Informal training should be provided through goat shows, market fairs, private sector profiles, handouts, and investment briefs.

General

Many other related topics were also discussed at the workshop. These included the value of further meetings such as this one, information exchange, and communication between countries in the Asian region. In particular, the need for and value of a network specific to small ruminants to promote regional collaboration on various aspects of research and development was discussed and its formation was recommended.

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